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A REVIEW AND EVALUATION OF RESEARCH ON THE LITERARY BRAILLE CODES

1900-1986

by

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Introduction

This review of research on the literary braille codes includes all literary braille codes of English speaking countries. An attempt was made to be as comprehensive as possible. However, it is possible that some studies were omitted. Such omissions were not intentional and studies will be added as they are identified. For purposes of this report, studies are primarily empirical in nature and are related to the braille codes themselves rather than to other aspects such as teaching methods, etc. A few studies reported do not meet these criteria, but were included because of their overall importance in relation to the development and uses of the codes.

The primary objectives of the review were as follows:

1. To organize and synthesize the existing research on the literary braille codes of English speaking countries.

2. To evaluate, whenever possible, the quality of the research (i.e., methodology).

3. To identify trends in research in the various time periods between 1900 and 1987. (For purposes of organizational convenience the research is reported in 10-year segments.)

4. To identify gaps in the research (i.e., areas that were not studied, but should have been).

5. To prioritize research needs in literary braille, based on the identification of the gaps identified in Objective 4 above.

Some brief discussions of the research for each 10-year time period is included in the summaries of each period except for the first. A 20-year period was included in this section because of the limited amount of research during this era and the fact that the majority of studies were done by the Uniform Type Committee. The major conclusions and priorities for future research are included in the last section.

Research on the Braille Codes
1900-1919

1900-1919

Research during this period consisted primarily of the work of the Uniform Type Committee. The basic purpose of all the studies conducted by this group was to examine the legibility of several embossed dot systems. This information was used to assist in the selection of a uniform embossed dot system for all braille readers. Although the research by the Uniform Type Committee was conducted on systems which are quite different than the systems in use today, the results had a significant impact on these codes. The codes which were compared and evaluated by the Uniform Type Committee were American Braille, English Braille, and New York Point. This work provided the basis for the ultimate adoption of grade 2 literary braille in the United States in 1932.

Evaluation. In general the studies reported by the Uniform Type Committee were empirical studies, although a few of them were discussions of some of the results of previous studies. The primary methodology faults were:

a. Procedures for obtaining reading times were not as refined as might be desirable.

b. By including large numbers of reproductions of a single character with other alphabetical characters, researchers failed to control for the effect of association of letters in a language.

c. Having the same character appear twice in the same lists precluded distinguishing between them on the basis of reading time and may have increased the error rate for these characters.

However, these faults probably did not bias results in favor of characters with fewer dots. In fact, future studies which did control these variables more rigidly obtained the same results.

Overall the Uniform Type Committee studies provided very valuable information which was needed badly at the time they were conducted.

Abstracts of Braille Studies
1900-1919

American Association of Workers for the Blind. (1907). Report of the Uniform Type Committee. Outlook for the Blind, 1, 154-162.

Purpose: To study and compare existing literary braille codes in order to adopt a uniform system for all braille readers.

Subjects: 246 individuals from 30 states, 56 readers of English Braille, 94 readers of American Braille, 96 readers of New York Point.

Procedure: A series of questions pertaining to the braille codes were prepared and submitted through periodicals, libraries and publishers for the blind asking all braille readers familiar with two or more systems to state which system they preferred.

Results and Conclusions: The number of trials were too small to warrant great certainty. However, the conclusions from this study show:

1. A system using few dots can be read more rapidly and accurately than one using many dots.

2. The system using fewer dots can be written with the Hall Braille Writer more rapidly and accurately than one using, many dots.

3. A system using characters one, two, and three points high can be read as rapidly and accurately as one using no characters more than two points high provided the number of dots are the same.

4. The unequivocal whole-word signs help in reading.

5. The equivocal whole-word signs are a decided hindrance in reading, both to speed and accuracy.

6. The unequivocal part-word signs help slightly in speed, but lessen accuracy in reading.

7. The equivocal part-word signs lessen (slightly) both speed and accuracy in reading.

8. The experiments of this study should be improved and repeated many times.

American Association of Workers for the Blind. (1909). Report of the Uniform Type Committee. Outlook for the Blind, 4, 73-82.

Purpose: To study and compare existing literary braille codes in order to adopt a uniform system for all braille readers. Several studies were conducted in this phase of the work of the Uniform Type Committee. They consisted of studying the effects of the number of dots in braille words, a comparison of writing on the Hall Braille Writer and writing on the Kleidograph, a study of the level of braille characters in New York Point, and the legibility of horizontal versus vertical spacing.

Subjects: The number of subjects varied among the several experiments and exact numbers were not given for some. In the study related to the number of dots per word, 39 readers were used, 12 subjects were used to compare the two braille writers, five were used in the study on the level of characters in New York Point, and 12 were used in the study on horizontal vs. vertical spacing. Data are not reported exactly in some of these studies.

Procedure: Subjects read or wrote lists of letters and words in New York Point and American Braille. Data analysis consisted of errors and reading time and results were reported in percentages.

Results and Conclusions:

1. Characters of few dots are more legible than those of many dots.

2. Characters of few dots can be written with the Hall Braille Writer, or with the Kleidograph, more rapidly and accurately than those with many dots.

3. The use of New York Point characters which are alike except for their level in the line, specifically, e and t, a and n, f and u, causes some hesitation and error in reading.

4. The unequivocal whole-word signs facilitate reading.

5. The vertical position is more legible than the horizontal.

6. When characters in New York Point which are four dots wide are introduced with those which are one, two, and three dots wide, legibility is greatly reduced.

American Association of Workers for the Blind. (1911). Report of the Uniform Type Committee. Outlook for the Blind, 5, 1-10.

Purpose: A continuation of the 1907 and 1911 studies.

Subjects: 16 students from New York State School for the Blind and 11 students from the Perkins School for the Blind.

Procedure: Subjects read lists of words in American Braille and New York Point. Data were analyzed to determine whether the number of dots, horizontal and vertical spacing, and use or non-use of capitals affected legibility. The analyses were conducted in terms of time and errors.

Results and Conclusions:

1. Words with fewer dots were read faster and more accurately.

2. Average time taken to read horizontal characters was more and the errors were more than for the vertical.

3. Time and certainty diminished when braille readers tried to determine the position of characters which are like other characters except for their level in the line.

4. Results were uncertain on the test with capitals because the test was given to 4th graders who were unfamiliar with the proper nouns used.

American Association of Workers for the Blind. (1913). Report of the Uniform Type Committee, Outlook for the Blind, 7, 2-48.

Purpose: To establish a standard or uniform system of writing and printing with four areas to be researched:

1. adaptability
2. legibility
3. economy
4. manner of final selection

Subjects: 1200 people from various schools in the United States, Nova Scotia and England. Those chosen were able to read more than one system of embossed type.

Procedure: Sheets of embossed material were given the subjects. Their ease of reading was based on: number of dots and vertical/horizontal positioning, similarity of letters (and any resulting confusion), method of capitalization, contractions which facilitated reading, size of type, and the best method of spacing. All the above mentioned were considered and noted for analysis.

Results and Conclusions: The committee felt that because of lack of time and readers (with some of their experiments), the results were not reliable for publication. Generally, they observed that:

1. The best readers use both hands, mainly using the index fingers with little up and down motion.
2. Most braille readers wanted a type of clear bold relief, with generous letter and line spaces.

The committee recommended modifying the British Braille and the American Braille to develop a system known as the Standard Dot System. They requested money be raised for their committee to continue its research.

American Association of Workers for the Blind. (1915). Report of the Uniform Type Committee. Outlook for the Blind, 9, 3-92.

Purpose: To examine the use of capitals, writing, music, and mathematics in developing a uniform code for all English speaking countries.

Subjects: 31 individuals tested in writing British Braille 48 in New York Point, 22 in American Braille.

Procedure:

1. Seven untried methods of capitalization were tested.
2. Dictated tests in writing with the tablet and machine were used.
3. Exercises in music--testing reading of notes and note values, octave signs, expression marks, and playing of intervals.
4. An investigation of the mathematical code was attempted.

Results and Conclusions:

1. Single-dot capital prefix or braille italic sign was preferred.
2. Time increased when writing characters of many dots as opposed to writing those of fewer dots.
3. Writing American and British Braille is faster than writing New York Point.
4. Any element causing confusion in the literary system has the same influence on the music system.
5. Few subjects were found who were familiar with the mathematics code therefore, the committee did not complete this phase of the study.

American Association of Workers for the Blind. (1917). Report of the Uniform Type Committee. Outlook for the Blind, III, 3-14.

Purpose: To determine which braille system would be acceptable to both American and Great Britain.

Subjects: Subjects were school superintendents, teachers, printers.

Procedure: A circular letter was sent to the subjects asking for support of a standard dot system.

Results and Conclusions:

1. The American Association of Workers for the Blind expressed a desire to have the question of uniform type settled without further delay.

2. A form of "Revised Braille" based on present Grades I and II, as Grade I 1/2 should be developed.

3. All publishers, schools and libraries should adopt Grade I 1/2 for universal use.

4. The Commission and British National Uniform Type Committee should continue working towards agreement regarding the whole question of uniform type.

Research on the Braille Codes
1920-1929

1920-1929

Studies reported in this time period looked at embossed print vs. embossed dot systems, and at grade 1 1/2 braille vs. grade 2 braille. This was due to the fact that grade 2 braille had not been formally adopted at this time.

Evaluation. It is difficult to locate detailed descriptions of the research procedures used in these studies. In the case of the Merry (1928) study, there seems to have been a review of currently available research. The Irwin (1929) study was designed to look at the space saving value of grade 2 braille as compared to grade 1 1/2 braille. Although these studies were not strictly controlled, they provided information that was later used in making the decision to adopt grade 2 braille.

Abstracts of Braille Studies
1920-1929

Merry, R. V. (1928). Factors Involved in Tactile Reading. New York: American Foundation for the Blind.

Purpose: To review and analyze the embossed type systems in the United States.

Procedure: Merry did not conduct studies himself. He simply reviewed studies which had been conducted at the time and summarized the results.

Results and Conclusions:

1. Arbitrary (and semi-arbitrary) systems of embossed print have been preferred to the alphabetical systems.

2. The two surviving systems were perfected by blind men.

3. Since the blind appear to possess no superior physiological sensitivity, it is thought that tactile reading is a central physiological process rather than a peripheral physiological process.

4. Moon type is more readable to adult blind than braille due to braille's complexity.

5. Medium height of point is preferable to either high or low points.

6. Suitability of the word method of teaching braille probably depends on whether a series of tactile stimuli may be as easily perceived as a complete visual stimulus.

Irwin, R. B., & Wilcox, R. E. (1929). A Comparative Study of Braille Grade One and a Half and Braille Grade Two. New York: American Foundation for the Blind.

Purpose: To compare the space-saving characteristics of grade 1 and 1/2 braille and grade 2 braille.

Procedure: Four selections which were available in either grade 1 1/2 or grade 2 braille. Words and letters were counted to determine which braille code saved the most space. A total of 91,564 words appeared in the four selections.

Results and Conclusions:

1. Grade 1 and 1/2 uses only 44 contractions, punctuation, and some composition signs.

2. Of the 91,564 words compared, words written in grade 1 1/2 occupied 427,776 cells. The same words written in grade 2 braille occupied 376,866 cells.

3. Therefore, Grade 2 braille saves approximately 12% of the cells used in Grade 1 and 1/2.

Research on the Braille Codes
1930-1939

1930-1939

Studies in this period were related to the writing of braille, teaching of contractions, the legibility of braille characters, tactual perception of characters, an attempt to develop braille symbols for chemical notations, and a comparison of braille reading speeds and comprehension of what is read. There does not appear to be a specific trend or focus on the braille research in this period. However, the area of tactual perception and sensitivity of the fingers for reading braille received slightly more emphasis than other areas.

Evaluation. The major problem, overall, in this period is the quantity of research being conducted. Most of the studies were well done, but there were too few to make any generalizations. The methodology faults were:

a. The small numbers of subjects in all studies in this section except for the survey by Niday (1939)

b. The use of tin nail heads and rubber caps in the Burklein study

The lack of more detailed information about the procedures and methodology makes evaluation difficult. However, several of these studies are well done and results have been used in developing teaching methods and materials for persons who use braille as their reading medium. Studies which are particularly strong in these areas are those by F. K. Merry (1930, 1932) and L.V. Funchess (1934).

Abstracts of Braille Studies
1930-1939

Merry, F. K. (1930). Shall we use the braille slate or the braille-writer with beginners? Teacher's Forum, 3, 3-6.

Purpose: To compare two methods of writing braille for the young beginning writer.

Subjects: 10 students from the Perkins Institute. None of the children had any previous experience with braille writing and all were classified as lower than normal intelligence level.

Procedure: The control group was taught braille in the traditional manner and the experimental group was taught the entire alphabet. The experimental group had words spelled to them orally and the control group had copies of the braille alphabet they could consult.

Results and Conclusions: For practical purposes, it appears that the braille writer is better suited to the need of the young beginning writers than the slate. Transfer to the slate would be more appropriate when the student gains the manual dexterity needed.

Merry, F. K. (1932). Shall we teach contractions to beginning braille readers? Teacher's Forum, 5, 35-37.

Purpose: To compare reading efficiency of groups of children respectively taught braille 1 1/2 and full spelling.

Subjects: Two groups of five children, I.Q range 87-126, were in the first study and two groups of four children, I.Q. 77-116, were in the second study.

Procedure: In the first study, Group I learned grade 1 and 1/2 and Group 2 learned full spelling. The groups were tested at the end of the school year. Precise methods were not described. The second study was a repeat of the first half of the first study. Gray's Oral Reading Check Tests, Sets I and II, were used. Three years later a follow-up on the reading and spelling components of the second study was conducted.

Results and Conclusions: No data were reported or results of tests of statistical significance given. However, reader of grade 1 1/2 read faster. Tests repeated with a different group of children showed grade one readers to be slightly more accurate and the grade 1 1/2students to be faster.

Burklen, K. (1932). Touch Reading of the Blind. (F. K. Merry, Trans.) New York: American Foundation of the Blind.

Purpose: To study various factors relevant to the reading of Braille:

1. legibility of the characters
2. touch movements of one reading finger
3. finger superiority
4. touch movements of both index fingers
5. variability of application of pressure in reading
6. fatigue and changes in tactual sensitivity during prolonged periods of reading
7. speed of touch reading

Subjects: Braille readers of all age levels attending the Neider-Osterreichische Landes-Blindenanstalt. The number of subjects used for each of the experiments ranged from 15-50.

Procedure: (Description inadequate and at times confusing.) Various contraptions and devices were employed in the studies.

In determining the legibility of the characters, rubber caps were placed over the tips of the subjects' reading fingers and the experimenter guided the reading fingers over stimuli embossed in tin, paper and nail heads exposed in a wooden surface.

A tastschreiber was developed to study touch movements of the fingers.

A type of pneumograph was used for studying pressure. An esthesiometer determined sensitivity prior to and following a 6-hour reading period.

Results and Conclusions:

1. Legibility was related to the configuration of contractions and the number of dots in the configurations.

2. The most desirable touch movements consist of a uniform, horizontal line with few irregularities. (confirmed by Eatman)

3. The study substantiates Grasemann's findings that the left finger is superior to the right.

4. Light pressure is more conducive to accurate, rapid perception. Heavier pressure is characteristic of poorer readers and difficult subject matter.

5. Six hours of reading produced barely discernible fatigue or change in sensitivity of the reading fingers.

6. Speed of Braille reading is four to five times slower than visual reading.

Hulin, W. S., & Katz, D. (1934). Transfer of training in reading braille. American Journal of Psychology, 46, 627-631.

Purpose: To examine the ability to read the braille alphabet with an untrained hand after the alphabet has been learned through the use of the other hand or has been learned visually.

Subjects: Five blindfolded sighted subjects

Procedure:

Tactual training: Subjects were trained to recognize letters of the braille alphabet with the index finger of the favored hand using a prompting method. Each subject was given one trial per day, letters were presented randomly until one perfect trial was complete. A posttest was immediately given using the index finger of the non-preferred hand.

Visual training: Training was the same as above except that the subjects learned to recognize the alphabet visually. After one perfect trial, subjects were blindfolded and required to recognize the alphabet tactually with the index finger of the right hand.

Results and Conclusions:

1. There is ready transfer from one hand to the other in tactually reading the braille alphabet.

2. The transfer of the tactual reading ability is greater (40%) for tactual training than for visual training, which indicated that transfer is not carried out wholly in terms of visual imagery.

Funchess, L. V. (1934). The psychology of reading braille with eight fingers. Unpublished Master's thesis, Louisiana State University.

Purpose: To determine whether braille readers can learn to use eight fingers in reading braille.

Subjects: Eight braille readers who differed greatly in age, training and experience.

Procedure: Six sets of stimuli (several pages to each) were presented to each subject three times. This was done by putting a stimulus sheet into a braillewriter and having the subject read grade 1 1/2 braille from left to right with the finger which was over the cell. The lines were double-spaced.
This provided for ten lines per page. Each set was precisely timed and a record of errors was kept.

1. Set one had eight cells per line and the subjects spelled the letters out.

2. Set two had two, two-letter words on each line, one under each hand. The subjects were asked to pronounce the two letter words. The first five pages of this set were read with the third and fourth fingers and the last five pages with the first and second fingers.

3. Set three was similar to set two except that three letter words were used and the subjects used forefingers less than other fingers.

4. Set four consisted of two four letter words per line.

5. Set five had two or three words per line.

6. Set six was of no particular value to the experiment except to demonstrate to the reader the way he would read if he had the facilities to accommodate the eight fingers. This was actually a short paragraph with a few grade two braille signs.

Results and Conclusions: Individual data for each set of stimuli were given. No attempt was made to combine it. Mistakes made by each finger during the trials and the total time and errors for each of the three presentations of the six sets were

given. There was no statistical treatment of the data. Each reader indicated that he could read and interpret with eight fingers. It appeared that the difference between the ability of a braille reader to read with one finger and his ability to read with eight fingers is a matter of training.

Loomis, M. S., & Mitchell, P. C. (1939). Braille chemical notations and how to use them. New York: New York Institute for the Education of the Blind.

Purpose: To develop a braille chemistry code which could be used in teaching modern chemistry.

Procedure: The authors developed the braille symbols to follow the methods of modern textbooks and laboratory procedures based on classroom experiences and Taylor's Mathematical and Chemical Notations (1917).

Results and Conclusions: The monograph was produced by the New York Institute for the Education of the Blind. This system has drawn on English, German and American usage of braille symbols. The rules of this system do not conflict with the previous use of braille in the United States.

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Niday, W. R. (1939). A nationwide survey of braille reading in speed and comprehension. Unpublished Master's thesis, Ohio State University.

Purpose: To compare speed and comprehension of braille reading with that of print reading.

Subjects: 2,538 braille readers grades 3-12 from residential and public schools and 130,000 sighted readers who constituted the normative group for the Monroe Standardized Silent Reading Test.

Procedure: Braille readers took Form I of the Monroe Standardized Silent Reading Test with certain arbitrary time extensions. Data analysis consisted of obtaining reading speeds and reading comprehension scores.

Results and Conclusions:

1. Sighted students read about 2-3 times as fast as braille students.

2. The comprehension of blind students was better than that of sighted pupils. However, pupils in schools for the blind are about three years behind their sighted peers.

3. Girls read faster and understand more braille material than boys.

4. Within grades, there appeared to be some correlation between reading speed and comprehension for braille reading.

Research on the Braille Codes
1940-1949

1940-1949

The most significant studies in this period were those by Eatman (Fertsch) which looked at a number of variables related to braille reading. These variables include speed, hand movements, tactual sensitivity, and hand dominance. Findings from these studies play a strong role in planning teaching procedures for young children who will use braille as their reading medium. In addition to the Eatman studies, the study of braille contractions by Hooper (1946) and Lowenfeld's (1945) study on reading speeds and comprehension have had a strong influence on educational procedures and materials for young blind children.

Evaluation. Overall, the methodology used in studies of this period was good. Some weaknesses, or faults, were:

a. Eatman (1942, 1946)--All subjects were from a single school.

b. Burns (1944)--subjects were sighted and all were from the same school.

c. Specific detail was lacking in journal articles.

Strengths were:

a. Eatman and Hooper studies were well planned and carried out.

b. Results had direct bearing on the teaching of braille reading to children.

Abstracts of Braille Studies
1940-1949

Eatman (Fertsch), P. F. (1942). An analytic study of braille reading, Unpublished doctoral dissertation, University of Texas.

Purpose: Investigation of the effects of the factors listed below on braille reading, grade one and one-half.

1. speed of oral and silent reading
2. return sweeps
3. regressive movements
4. degree of vision
5. stereognostic ability
6. tactual sensitivity
7. hand dominance, or extent to which the two hands share in reading

Subjects: Sixty-three subjects from the Texas School for the Blind (30 girls and 33 boys) were selected via the Otis Classification Test and the Monroe Silent Reading Test and grouped into good (upper 1/3) and poor (lower 1/3), readers having average or above intelligence.

Procedure: Each subject, on three different occasions within a three month period, was given special tests of tactual sensitivity (locate wire under varying thicknesses of paper), stereognosis (recognize eleven familiar objects) and reading (several paragraphs both orally and silently with both hands separately and together). The readings were timed or recorded with a motion picture camera.

Results and Conclusions:

1. Silent reading is performed more rapidly than oral reading by both good and poor readers.
2. Poor readers make twice as many regressive movements with both hands as do good readers. In oral and silent reading by both groups, regressive movements of the left hand exceeded those of the right hand, with the exception that the order was changed when the poor group read aloud.

3. Return sweeps account for 6-7% of the total reading time and are effected by the hands conjointly (poorer readers) or independently (better readers).

4. Subjects with very little or no vision read faster orally and silently than those with considerable vision.

5. No significant differences were formed between groups on recognition task (stereognostic ability).

6. No significant differences between groups were found on finger sensitivity task.

7. The right hand was found to be dominant. For the most part, in the better readers, the hands seemingly share equally. Next in line are right-handed readers, and lastly, left-handed readers, or rather those in whom these respective hands are dominant.

Eatman (Fertsch), P. F. (1946). An analytic study of braille reading. Outlook for the Blind, 40, 128-131.

Purpose: Investigation of the effects of the following factors on braille reading, grade one and one-half:

1. speed of oral and silent reading
2. return sweeps
3. regressive movements
4. degree of vision
5. stereognostic ability
6. tactual sensitivity
7. hand dominance, or extent the two hands share in reading.

Subjects: Sixty-three subjects from the Texas School for the Blind, (30 girls and 33 boys) were selected by their scores on standardized tests and grouped into good (upper 1/3) and poor (lower 1/3) readers having average or above average intelligence. These students were in grades 3-11.

Procedure: The Otis Classification Test and Monroe Silent Reading Test were used for selection of subjects. The Gates Reading test, Form 2 was used for test material. Varying thicknesses of wire was used for tactual sensitivity and a motion picture camera was used for recording and timing.

During a three month period each subject was given three tests of tactual sensitivity, stereognosis and reading (both silently and orally) with both hands separately and together.

Results and Conclusions:

1. Silent reading is performed more rapidly than oral reading by both good and poor readers.
2. Poor readers make twice as many regressive movements with both hands as do good readers. In oral and silent reading by both groups, regressive movements of the left hand exceeded those of the right hand, with the exception that the order was changed when the poor group read aloud.

3. Return sweeps account for 6-7% of the total reading time and are affected by the hands conjointly (poorer readers) or independently (better readers).

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6. No significant difference between groups was found on finger sensitivity task.

7. The right hand was found to be dominant. For the most part, in the better readers, the hands seemingly share equally; next in line are right-handed readers, and lastly, left-handed readers, or rather those in whom these respective hands are dominant.

Burns, B. K. (1944). A comparative study of the visual and tactual learning of braille. Unpublished master's thesis, Wittenberg College, Springfield, OH.

Purpose: To compare rates for learning braille when learned visually, visual-tactually and tactually.

Subjects: Sixty freshmen psychology students at Wittenberg College were divided into three equal groups and matched for intelligence: Group I--visual learning, Group II--visual-tactual, and Group III--tactual.

Procedure: All groups learned to recognize seven braille letters embossed individually on cards and presented in random order. Using massed practice, Groups I and II had five perfect trials for the set of seven. Immediately following this trial, all groups were given 175 tactual learning trials. During tactual training a screen was used to obstruct viewing the stimulus card. Data Analyses compared the groups in terms of their ability to recognize the symbols.

Results and Conclusions:

1. The visual and visual-tactual experienced groups were greatly superior to the non-experienced groups in learning to recognize braille symbols tactually.

2. There was no appreciable difference between the groups with visual and visual-tactual pretraining in later tactual learning of braille symbols.

Lowenfeld, B. (1945). Braille and talking book reading: A comparative study. New York: American Foundation for the Blind.

Purpose: To compare speed and comprehension of braille and talking book reading and note preferences of children for either.

Subjects: 481 pupils in grades 3, 4, 6, and 7.

Procedures: The younger students were given six stories each in talking book with sound effects, six tests in braille and six tests in talking book only. All students were tested for timed reading and comprehension and asked to give their personal preferences. The younger students were asked to list in order the four stories they liked the best. These were tabulated by method of reading.

Results and Conclusions:

1. The rate of braille reading was 1/3 that of talking book reading.

2. Talking book comprehension was significantly superior to braille reading for 3rd and 4th grades.

3. For grades 6 and 7, no difference in comprehension was found for stories, while comprehension of textbook material was significantly greater for braille reading.

Hooper, M. S. (1946). Braille contractions and children's reading vocabularies. Proceedings of American Association of Workers for the Blind.

Purpose: To tabulate the occurrence of grade 2 braille contractions as they appear in primary school children's reading vocabulary according to grade level.

Procedure: Words containing grade 2 braille contractions were collected from Stone's Graded Vocabulary for Primary Reading, Dolch and Buckingham's Combined Word List, and 21 reading series printed in braille and classified according to grade level. The Thorndike Word List was used to determine the general frequency of occurrence of the contractions.

Results and Conclusions: From a total of 13,038 words containing the braille grade 2 contractions, 180 contractions appeared a total of 6.453 times in school grades 1-6 inclusive. One-hundred and forty-four were used in the vocabularies of children in the 1st grade, 17 more in the 2nd grade, 5 more in grade three, six more in grade four, three more in grade five and five more in grade six. Five are used in adult speech (braille, conceive, conceiving, oneself, and thyself). One hundred fifty-two of the contractions were rated in the first 1000 category of the Thorndike Word List.

Fertsch, P. (1947). Hand dominance in reading braille. American Journal of Psychology, 60, 335-49.

Purpose: To investigate the problem of handedness and hand dominance in braille reading.

Subjects: 33 blind boys and 30 blind girls of average or above intelligence who scored in the upper or lower thirds on Monroe Test of Reading Comprehension.

Procedure: The Shank Test of Reading Comprehension was used to test for hand dominance. The reading performance of each hand was tested separately. Measures of both reading time and comprehension were obtained. Motion picture records of reading performance were obtained using both oral and silent reading. Comprehension was tested at the same time.

A hand dynamometer was used to determine handedness through the correlation of hand-strength and hand preference. Not enough left-handed persons were available for study.

Results and Conclusions:

1. On the basis of performance when the hands read separately, blind readers may be classified into right dominant, left-dominant, and hands equal groups.

2. The hands equal group read a larger number of braille cells with the hands functioning independently, read faster, and contained fewer poor readers than the other two groups.

3. The right dominant group read almost as many braille cells with the hands separate and almost as fast as the hands equal group and had an equal number of good and poor readers.

4. The left dominant group read a small amount of material with the hands functioning independently, read slowest of the three groups and read twice as many poor readers as good readers.

5. Good readers read a substantial amount of material with the hands functioning independently. They read twice as much with the right hand as the left.
6. Poor readers keep the right and left fingers close together and consequently read very little with the hands independently.

Research on the Braille Codes
1950-1959

1950-1959

Research in this period focused primarily on the physical characteristics of the braille cell, such as dot combinations, size, and spacing. In addition, study investigated the results of introducing grade 2 braille to young children and another looked at the mental processes involved in braille reading.

Evaluation. The Meyers and Ethington (1958), Calvin (1958), and Meyers, Zickel, Ashcroft, Clark, and Calvin (1958) studies are well known and results have been used to set the physical standards for the braille cell. The studies were carefully conducted and methodology faults are controlled to the greatest extent possible. Data on the Biggs (1950) study are incomplete and the Harback (1951) study used only six sighted subjects.

Abstracts of Braille Studies
1950-1959

Biggs, I. (1950). The introduction of grade two braille in the primary grades. Outlook for the Blind, 44(4), 103-105.

Purpose: To determine the feasibility of teaching Grade 2 braille to beginning readers.

Subjects: 10 children, ages 6-10, at the Texas School for the Blind. Two of the children were Spanish speaking. The other eight had an average I.Q. of 107.

Procedure: Grade 2 braille was presented to the experimental group by means of a graded word-phrase-sentence methodology. Subjects learned word and phrase forms. Writing, spelling and learning the dot numbers were introduced after the child had built a simple "touch" vocabulary.

Results and Conclusions: No statistical analyses were reported. Results reported indicated that at the end of the 1st grade the children were using materials that were considered to be end of 2nd grade level in the public schools. The average reading level at mid-term was 2nd grade, first month for regular second graders and 2nd grade, third month for the experimental group.

The teachers involved felt the early introduction of grade 2 braille was advantageous in terms of space saved and elimination of relearning. Also, it was thought to be less fatiguing and tedious and better for the slower reader.

Horbach, H. (1951). Tactile reading: Observations and experiments. Dueren, Germany: Dueren School for the Blind.

Purpose: To conduct two studies (A and B) to investigate the multiformity of the reading process in braille (the mental process as well as the tactile process).

Subjects: Group I--Six sighted employees of the Dueren School for the Blind; Group II--Twelve students at the Dueren School for the Blind for the year 1923. Group III--Twelve students at the Dueren School for the Blind for the year 1950.

Procedure: The author made up braille reading sheets of differing difficulties and then mixed in nonsense words or spaced the braille out over unusual cell lengths, for example, blank cells between the letters, etc. Experiments and their results will be outlined together for brevity.

Results and Conclusions:

Factors under Study A:

1. Undertook to determine the portions of the fingers that are sensitive enough for reading and determined that all areas are sensitive except the part directly before the nail.

2. Compared the visual reading of braille and the visual reading of print and determined that it is a great deal harder to visually read braille.

3. Tested the recognition of various letter forms in the reading of individual signs and words. Oral reading differences were between 35-64% and silent reading differences were between 16-39%.

4. Established the shortest span of time in which individual letters and words could be recognized through touch--between .04 and .08 seconds.

Factors under Study B:

1. Compared the amount of time that is used in the reading of texts that are either compact or interrupted. Reading of a compact text saves 71% of

the time of reading an interrupted text. A comparison of the results of A-3 indicated that the letters from an interrupted text still have a time saving of 32% in contrast to isolated individual letters.

2. Examined the influence of the sense coherence of a word and found that this influence achieved time savings of 63 and 71%.

3. Compared the influence of sense coherence in the reading of texts and of meaningful individual words and found differences of 13 to 63%.

4. Determined that the difficulty of materials increased reading times 6-228%.

5. Determined that when the reader lacks any conception of the material (i.e. Latin words) reading time increased 63-72%.

6. Determined the importance of context for word recognition.

7. Determined that the 60% of the word was sufficient in context to give meaning of the whole.

8. Determined that the attention of matters other than pure reading (i.e. proofreading) increased reading times 20-46%.

9. Determined that momentary rewards influenced the reading process.

10. Compared reading speeds of various forms of braille and determined that contracted forms saved a mean time of 15.2%.

11. Compared the speed of touch reading with visual reading and determined that touch reading of contracted braille approached visual reading except when reading individual items.

Meyers, E. & Ethington, D. (1958). Readability of braille as a function of three spacing variables. Journal of Applied Psychology, 42, 163-165.

Purpose: To determine the best combination of dot, cell, and line spacings in printing Braille.

Subjects: 275 students in fifth grade and higher and 167 adults. The average reading rate of the children was 68 wpm and for the adults 91.5 wpm. Twenty-seven groups of four children were selected from the children's distribution. In a similar manner, twenty-seven groups of four adults were selected.

Procedure: The reading material was the Black Arrow by Robert L. Stevenson. The book was printed in several different combinations of dot, cell, and line spacings. The values employed in the study were:

dot spacing .080, .090, and .100
cell spacing .125, .140, and .160
line spacing .163, .220, and .300

All subjects were given a 30 minute pretest reading to eliminate people with poor comprehension and to establish baseline reading rates. All subjects read for two 50 minute sessions on successive days. The instructions were to read every word and subjects were timed at the end of each page. Comprehension questions were asked at the end of the 2nd 50 minute period. Questions concerning the braille code were also asked of the subjects.

Results and conclusions: The data for children and adults were analyzed separately. Several kinds of analyses were made. From these analyses, it was determined that the following braille specifications seemed superior:

	for children	for adults
Dot Spacing	* .090 or .100	* .090 or .100
Cell Spacing	.125 or .140	* .160
Line Spacing	* .230	* .220

* Denotes the present standard spacing in braille printing.

The problem of knowing whether these spacings were superior because of superior printing/reading characteristics or if they were superior because these represented the size that the braille readers would be familiar with from past experience is not possible to conclusively answer from this experiment.

Calvin, J. S., & Clark, J. (1958). Influence of type characteristics on braille reading. Unpublished Report, American Printing House for the Blind, Louisville, Kentucky.

Purpose: To investigate the readability of braille whose physical dimensions have been varied in five orders. A small-scale replication of Meyers et. al. (1958) study. Standard braille of .090 (dot), .160 (cell), and .220 (line) was compared with four orders under the standard size.

Subjects: 100 braille readers from the Chicago area were randomly assigned to one of five groups.

Procedure: Subjects read chapters one through eight of the Black Arrow by Robert Lewis Stevenson. A preliminary reading session established no statistically significant differences between the five groups. However, obvious differences prompted analysis of covariance of the experimental results. A trend analysis was performed to determine practice effects between the sessions.

Results:

1. Standard braille and the combination .090-.140-.220 were read most rapidly. Speed fell off considerably as dimensions became smaller.

2. Trend analysis turned up a significant practice effect, the second session being superior.

3. It was not possible to establish conclusively that the standard braille cell used was superior.

Meyers, E., Zickel, V., Ashcroft, S., Clark, J., & Calvin, J. (1958). The influence of type characteristic on braille reading. Unpublished manuscript, American Printing House for the Blind, Louisville, Kentucky.

Purpose: The study was done as a more indepth replication of the Meyers, Ethington (1958) study to show the effect of the type characteristics of braille printing on its readability.

Subjects: 127 subjects who were braille readers.

Procedure: Subjects read the 12th and 13th chapters of The Black Arrow by Stevenson. After a thirty minute period of reading, the Subjects were given a comprehension test and the lowest 27 were eliminated from the study. The remaining group of subjects was divided into five groups of 20 people each on a random basis. Each group was given a different combination of braille to read. The first eight chapters of The Black Arrow had been produced in each of the five combinations:

dot	cell	line
.090	.160	.220
.090	.140	.220
.090	.123	.220
.080	.160	.220
.080	.123	.163

The subjects were given two 50 minute sessions and the time was recorded at the end of each alternate page, allowing for a measure of each subject's speed.

Results and Conclusions: This study verified the results of the Meyers, Ethington (1958) study in finding that standard braille is more readable than other forms of braille. This may be true for one of two reasons: (a) superior printing characteristics or (b) it is more readable because it is what the subjects learned to read. Thus, it may be possible that there is nothing inherent in standard braille which makes it more readable.

There are several kinds of close spacing; closeness of dots within the cell, closeness of two lines of print, closeness of adjacent cells in a horizontal line of print and closeness of two lines of print. The consistent superiority of .090 over .080 spacing suggests that spacing of dots within the cells may be the

most important. The results indicate that the .090 (distance between dots) and .160 (distance between cells in a line of print) and .220 (distance between lines of print) and .090-.014-.220 were read the most rapidly and .090-.123.-163 read the least rapidly.

Research on the Braille Codes
1960-1969

1960-1969

During this period, the volume of research was greater than at almost any time from 1900 through 1986. This is probably due to the fact that funds for conducting research were more readily available than at any other time. As a result, some of the most significant research available on the braille code was done during this 10-year period.

Evaluation. The landmark studies of this period still provide the basis for the development of educational materials for braille readers. Those of particular importance are Ashcroft (1960), Kederis (1962), Kederis, Siems, and Haynes (1965), Nolan and Kederis (1963, 1969), and Lowenfeld, Abel, and Hatlen (1969). These studies provided detailed information about the difficulty of various components of the braille code and also provided a description of the ways in which teachers taught children who use braille to read. The impact of these studies on the development of educational materials and teaching methodology is still being felt. Very little recent research has focused on the aspects of grade 2 braille which were investigated in this 10-year period.

In general, the methodology is very good. This is particularly true of those studies mentioned above. The major methodology faults were related to the number of subjects or to the representativeness of the samples. These problems are those that traditionally occur with low-incidence populations.

Abstracts of Braille Studies
1960-1969

Ashcroft, S. C. (1960). Errors in oral reading of braille at the elementary grade levels. Dissertation Abstracts International, 21/09, 2621.

Purpose: To study the oral performance of children reading braille in order to identify errors and classify these according to type, frequency, and grade level.

Subjects: 728 braille readers of both sexes in grades 2-6 who did not possess additional handicaps that would seriously affect their reading behavior.

Procedures: Subjects were required to read twelve passages, each one becoming increasingly more difficult. These paragraphs contained all the contractions in grade 2 braille. The material was presented individually and errors made were recorded verbatim according to a standardized procedure.

Results and Conclusions: Eight types of errors were found. The types of errors together with their relative percents of occurrence were: missed dots, 16%; ending problems, 15%; reversals, 13%; added dots, 13%; association, 12%; gross substitutions, 12%; up and down alignment, 10%; and left and right alignment, 9%.

In orthography (spelling), the order of errors from most to the least was: short-form words, combinations of orthography, multiple cell contractions, lower contractions, upper contractions, full spelling of short familiar words and alphabet abbreviations. The first three categories above included only 28% of the total number of the words but contributed 46% of the total number of errors made.

From the behavioral standpoint, the eight error types could be classified as arising from problems of perception (missed dots, added dots, and ending problems), problems of orientation (reversals, vertical alignment and horizontal alignment), and from problems of memory (association errors and gross substitutions).

Recommendations for changing grade 2 braille were given by the author. These recommendations were based on the information gained from the study. Unfortunately, these changes were not made. Attention should be given to them and, perhaps, a replication of the study should be considered.

Pamphlet File
Research Library
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Henderson, F. (1961). Analysis of errors in braille word recognition. Master's Thesis, George Peabody College for Teachers, Nashville, Tennessee.

Purpose: To study the frequency of certain types of braille errors in elementary grades.

Subjects: 45 pupils in grades 1-6 at the Tennessee State School for the Blind. Subjects were selected and placed according to grade level on the basis of performance on the Gilmore Reading Paragraphs.

Procedure: A word discrimination test was constructed in which the examiner read a word and the subject had to find the correctly spelled form of the word out of five choices. The words were graded in difficulty by using the Thorndike list and the vocabulary list of the Ginn Basic Readers. The four foils contained reversals, missed dots, added dots, and substitutions.

Results and Conclusions: All error types were more prevalent in the first few grades. No statistical tests were made for the differences between grades or types of errors, although it is obvious that a majority of the differences would have been significant. The frequency of all error types steadily declined as grade level increased until at the 6th grade level, the frequency of all error types at this level was 3% or less with the exception of vertical alignment which was 5 1/2%.

Kusajima, T. (1961). Psychology of the Blind. Tokyo Central Kohan: Tokyo, Japan.

Purpose: To evaluate Heller's theory of separate functions (synthetic and analytic) of the right and left hands in two-handed braille reading and to determine role of hands if different from Heller's supposition.

Subjects: 200 totally and partially blind students aged 10-25 years at the Tokyo Governmental School for the Blind.

Procedure: The following experiments were performed:

1. The touch movements of each finger were recorded.

2. Reading times were measured for both hands and the preferred hand on passages equal in length and difficulty.

3. Similar and different sentences were read through an aperture with right and left index finger simultaneously as the material revolved on a drum.

Results and Conclusions: The results gave no time scores and presented only three diagrams of touch movements. They showed little difference between time for reading with both hands and with preferred hand. Records of touch movements showed similar participation of right and left hand. They did not show movement of return sweeps. Results were contrary to those of Eatman and Holland who found that the two hands are not always in direct contact with each other over the entire length of line. They also found that the left hand usually follows the right by a few cells and returns to the next line at approximately the center of the line.

The author hypothesized that the real role of the left, or non-preferred finger was to supplement and correct impressions of the reading finger. Possibly the results were artifacts of the apparatus and experimental situation.

Rawls, R., and Lewis, E. E. (1961). Braille writing in schools and day classes for the blind in the United States. International Journal for the Education of the Blind, 11 (2), 42-46.

Purpose: To study the most efficient methods of presenting braille writing to children.

Subjects: Students in 34 state residential schools for the blind and 37 day school classes.

Procedure: Questionnaires were sent to the teachers, eliciting the following information:

1. the grade level at which beginning braille is taught
2. apparatus used for teaching braille writing and whether this apparatus was used for all beginners in the class
3. at what grade level various writing equipment is introduced

Results and Conclusions: No statistical tests were used since this was a study.

1. In most schools and day classes (68%), braille writing was introduced in the first half of first grade.
2. In 66 residential schools and day classes combined, a braillewriter was used in teaching beginning braille writing.
3. Most schools and day classes introduced the braillewriter in the first grade.
4. The fourth grade was the average grade level at which typing was introduced.
5. A majority of the day classes (24) and residential schools (20) introduced braille reading and writing simultaneously.

Karp, S. (1962). An experiment using revised stimulus presentation. Research Bulletin, American Foundation for the Blind, No. 2, 12-14.

Purpose: To determine whether the mode of presentation of stimuli affects the facilitation of learning.

Subjects: 12 sighted male students at the Massachusetts Institute of Technology.

Procedure: Six stimuli were used in this study which consisted of either two, three, or six escutcheon pins mounted on cardboard bases.

Each subject was asked to identify each of the six stimuli without looking at them. Three methods of presentation were used:

1. place movement in which the stimulus was given directly under the subject's fingers,

2. movement technique in which the stimulus was moved across the subject's finger at a speed controlled by the experimenter,

3. free movement in which the subject was allowed to move his fingers freely over the stimuli.

When the subjects had completed this task, the same stimuli were presented to them in varying methods of presentation. Half the presentations were tangential where the stimulus was presented so that the line of pins was parallel to the line of the subject's fingers. The other half of the presentations were perpendicular or lateral. The statistical procedure used was analysis of variance.

Results and Conclusions:

1. Results of the motor participation segment of the study showed that the free movement method was significantly better than the other two methods.

2. There was no significant difference between the lateral and tangential methods of presentation.

Staack, G. F. (1962). A study of braille code revisions. American Foundation for the Blind, Research Bulletin. 2, 21-37.

Purpose: To determine what revisions of grade two braille are necessary to make it possible to translate from regular printed material to braille mechanically.

Subjects: Small group of blind people. A detailed description of the subjects was not given.

Procedure: Three criteria were developed for the study of braille contractions. They were:

1. Their ability to save space by their frequency of occurrence and the number of characters saved each time they are used.

2. Their effect on the readability of braille as evaluated by previous studies.

3. The ease with which they could be translated mechanically without consideration of pronunciation or syllabification.

The contractions were divided into groups on the basis of their braille form and the rules governing their use. The contractions within each category were then evaluated with respect to the above three points. Specific recommendations were made concerning the omission of infrequent current contractions, the adoption of new contractions, and changing the rules restricting the use of some contractions. The overall efficiency of the braille contractions system as a means of saving characters is evaluated in terms of the mathematical theory of communication.

Results and Conclusions: Both the results of the reading test and the comments of the subjects strongly indicated that the recommended changes could be adopted with little problem for the average blind person and with desirable long range effects.

A computer program was written to count the frequency of contractions in various texts and to record the words in which they occur. This program was to serve as a useful tool in future evaluation of present contractions, and also proposed changes of contractions and existing braille rules.

Kederis, C. (1962). Legibility of braille characters, Master's Thesis, University of Louisville, Louisville, KY.

Purpose: To establish recognition thresholds for 55 of the single cell braille characters, gather the data from this and use the data to assess the effect of the number and configuration of dots on the legibility of the characters.

Subjects: 18 male and female blind skilled braille readers attending the Kentucky, Kansas, and Tennessee State Schools for the Blind, (grades 4-12). These students were equally divided by reading level as determined by scores on the Gray's Standard Oral Reading Check List.

Procedure: Each subject had four one-hour sessions on succeeding days. The first session was an individual oral reading test using Gray's Check List. Qualifying subjects were then given practice and familiarization with the tachistotactometer and the test procedures. Threshold values were established for the first page of characters. On the second and succeeding sessions two parts a day were presented and the data recorded for each subject.

The characters were presented in random order at .01 seconds and increasing amounts of time in .01 second intervals up to a minute. The material was presented a line at a time with time adjustment between lines. The lines were presented in random order until all characters had been identified.

Results and Conclusions: Characters containing fewer dots were more easily identified than those with a greater number of dots. As the number of dots in the characters increased the probability of missing one of the dots also increased.

On the basis of the findings, then, one could justifibly conclude the recognition of the single-cell character is principally determined by the number of dots in the characters with the configurations playing a secondary role.

Other factors such as reversals and alignment problems seemed to affect recognition of the characters significantly.

Heger, F. E. (1964). The comparative roles of braille and the talking book in the adult lives of a group of former braille students. Dissertation Abstracts International. 25, (2), 1004. (University Microfiche No. 64-8168).

Purpose: To investigate the long-term usefulness of braille as compared to that of talking book in the lives of a selected sample of blind adults.

Subjects: 79 subjects residing in the Detroit area who had received braille instruction in either residential or public schools.

Procedure: A questionnaire was used to determine how many subjects used braille and how many used talking books for reading. In addition, the number of subjects who used braille and talking books and their purpose for using them was determined. The Gray Oral Reading Paragraphs were administered to sixty-four of the subjects to evaluate reading proficiency.

Results and Conclusions:

1. Almost 70% of the subjects used braille, while 81% used the talking book. For both braille and the talking book, a larger number indicated more avocational uses than vocational uses. However, those subjects who did use either technique in vocational purposes tended to use it on a more frequent basis. Vocationally, a slightly larger number used the talking book than braille.

2. Braille was more popular as a means of writing than as a means of reading. Specific uses of braille writing included taking telephone messages and lecture notes, filing personal data, keeping recipes, and corresponding with friends. For reading, the talking book and other auditory media were preferred by the majority. This finding was confirmed by library records.

3. Brighter, better-educated subjects appeared to be more likely to utilize both braille and the talking book. Braille users were also characterized by more severe visual loss and a higher level of braille reading proficiency. Such other factors as the subject's age, sex, marital status, employment, the particular source of his braille instruction, and certain attitudes toward braille were of doubtful relevance to the tendency to use either braille or talking books.

4. The subjects who read the oral paragraphs were more handicapped in rate than in ability level. The mean ninth-grade level was comparable to that of the sighted adult, but the mean rate of thirty-three words per minute was much slower.

The investigator was encouraged that braille continue to be useful to some extent to the majority of the subjects. However, the relative slowness with which subjects read braille and their tendency to prefer braille primarily as a means of writing and auditory techniques for most types of reading imply the need for a reassessment of the roles of the various media employed to educate the blind.

Nolan, C. Y., and Kederis, C. J. (1963). Braille word recognition as a function of word length, familiarity and orthography, Unpublished paper. American Printing House for the Blind, Louisville, KY.

Purpose: To compare recognition thresholds for braille words organized into various combinations of word length, familiarity and orthography.

Subjects: Students from the Kentucky School for the Blind, ages 9-29 in grades 5-12 who had previously participated in a study of the legibility of braille characters and who lived near the school were used as subjects for this study.

Procedure: Words were presented on the tachistotactometer to the subjects for varying lengths of time. The words differed in (a) length 3, 5 to 7 characters, (b) orthography including both fully spelled out and contracted words, and (c) familiarity of the words. Familiarity of the words was determined by their appearance in English print as calculated by Thorndike (1932). Analysis of Variance was used for data analysis.

Results and Conclusions: Principal data recorded for each subject was the exposure time when each word was correctly identified. The subjects' score for any treatment combination (length x familiarity, etc.) was the mean time for the three stimulus words in that category. Generally these means become larger as that variable becomes more complex.

All main effects (familiarity, orthography, and word length) were significant far beyond the .01 level of confidence. Further inspection revealed that all second order interactions except length x orthography and the third order interactions were significant at this same level. Therefore, the treatment effects were not simple but related in what appeared to be a quite complex manner. Whole words were read more easily than unfamiliar words or unconnected letters. In print reading, little difference between words of four to fifteen letters was found in the reading times but in braille an increase of just three to five characters required an increase of 74% in recognition time. Print was read as whole words whereas braille was a rapid integration of a character by character process.

Kederis, C. J., Siems, J. R., and Haynes, R. L. (1965). A frequency count of the symbology of English braille grade 2, American usage. International Journal for the Education of the Blind, 15, 38-46.

Purpose: To obtain a representative and up-to-date frequency count of the occurrence of 256 elements of the braille code.

Procedure: Twelve books were selected randomly from a list of 45. Two books per reading level were selected for grades 4-7, 7-9, and adult. From each of these twelve books, one braille volume was used in the count. A total of 924,760 braille elements were included in the sample (1,255,407 letters in English print).

The frequencies were obtained on an IBM 709 computer used at the American Printing House for the Blind as part of an automated process of producing braille from inkprint. The count was accomplished by modifying part of the program which is used in the translation process.

Results and Conclusions: Tables give the number of times each of the 256 elements of the braille code appeared in the sample along with the number of inkprint letters saved by each of the contractions (a total of 31%).

Numbers of occurrences of the alphabet letters in English print are given. They are, in descending order: E, T, A, O, N, H, I, S, R, D, L, U, W, M, C, G, F, Y, P, B, K, V, J. X, Z, Q.

Numbers of occurrences of the 63 single-cell braille characters is given. Braille was found to take approximately 26.5% less space than print letters.

A frequency count of the number of occurrences of dots by position within the braille cell shows the descending order to be dot positions 1, 3, 2, 4, 5, 6.

Flanigan, P. J. (1966). Automated training and braille reading, The New Outlook for the Blind, 60, 141-146.

Purpose: To learn whether several of the variables involved in the traditional braille reading process could be influenced by training on an automated self-learning device.

Subjects: 30 elementary and junior high students from the Wisconsin School for the Visually Handicapped. The students were functional braille readers from 12 to 19 years old with IQ's from 65 to 145. They were randomly assigned to experimental or control groups.

Procedure: The Wide Range Vocabulary Test and braille reading tasks developed from the Science Research Association were used to test speed and comprehension. The reading materials were from grade levels 2.0 to 13.0. The materials were categorized into graded vocabulary and interest levels for all subjects.

The materials for the control group were in traditional braille form. The materials for the experimental group were cut into strips butted together and put on a reel for the braille tape reader. The machine itself has a presentation area 7" by 3/4" cut in a 12" by 2" hand rest plate. The tape travels right to left at variable speeds. The device is designed so that the subjects' fingers remain stationary.

Results and Conclusions:

1. The performance of the experimental subjects was significantly superior to that of the control subjects following treatment.

2. Following a noninstructional period the experimental group gains, with minor exceptions, remained constant.

3. Nonsignificant treatment effects were noted on comprehension and reading achievement levels as a function of the method of reading.

4. The appropriateness of sequenced grade level reading instruction was pointed out.

Stockton, G. H. (1966). Effectiveness of programmed learning of braille instruction for the adult blind. Dissertation Abstracts International, 26, 5308-5310. (University Microfilms No. 65-14, 933).

Purpose: To examine the effects of programmed instructional materials on the braille reading ability of adults.

Subjects: 31 vocational rehabilitation students ranging in age from 19 to 67 years who attended the Wisconsin School for the Visually Handicapped.

Procedure: Subjects were randomly assigned to experimental and control groups. The experimental group used programmed instructional materials as a supplement to traditional braille instruction. The control group used the traditional curriculum alone. The supplemental training received by the experimental group included: (a) prereading training on a series of tactual graphic figures which were graded for difficulty followed by braille character discrimination training using a self-pacing teaching device and program display apparatus (Device 1), (b) training on braille symbols using a tachistoscopic type device designed to increase accuracy and speed of recognition (Device 2), and (c) training braille symbols using a continuously moving tape operated by a device (Device 3) on which speed was controlled either by the subject or the experimenter.

Results and Conclusions:

1. All groups improved in braille reading ability but the experimental subjects made more obvious gains at or near the .05 level of significance.

2. A significant decrease (.01) in braille reading errors occurred in the experimental group.

3. The experimental group had a significant decrease (.005) in retracing movements.

4. The experimental group had a significant decrease (.005) in up-down movements.

5. The experimental group tactually read single cell characters at a faster rate than the control group.

6. There did not appear to be any significant loss or gain in comprehension when reading a braille book in conventional format or on a braille tape reader. However, a saving of time (efficiency) was evident when utilizing the tape.

Stocker, C. S., and Walton, M. J. (1967). Exploring a more efficient method of teaching braille. New Outlook for the Blind, 61, 151-154.

Purpose: To evaluate a new technique for teaching adults to read and write braille.

Subjects: 65 adventitiously blinded adults served by the Rehabilitation Center for the Blind at Topeka, Kansas.

Procedure: Two groups of subjects with no prior knowledge of braille were taught braille by different techniques. One group of 33 was first taught grade 1 braille, then grade 1 and 1/2, and finally grade 2. The other group (N=32) was taught the contractions of grade 2 braille simultaneously with the alphabet. It was assumed members of this group already knew how to spell since they were adults. The training period for both groups was four months.

Results and Conclusions: Only 18.2% of the subjects trained by the three step technique completed grade 2 training during the four month training period as compared to 62.5% of the group taught grade 2 braille and the alphabet.

Hanley, L. P. (1967). The construction of an individual diagnostic test of braille perceptual skills, (Vol. 1), Dissertation Abstracts International, 28, 496-A.

Purpose: To construct and to validate an instrument which would isolate and categorize types of perception errors peculiar to grade 2 braille symbols. The instrument analyzed errors according to specific types of misperceptions and categories of braille orthography.

Subjects: 192 blind children in grades two through five in three residential schools and five public school programs for the visually handicapped. There were 48 subjects at each grade level who were equally distributed according to sex, type of school attended, and form of the test.

Procedure: The content of the test was determined by examining the individual braille symbols. This resulted in seven categories of errors: perception errors, missed dots, added dots, horizontal errors, horizontal alignment errors, reversal vertical alignment errors, and diagonal alignment errors. Five modes of presentation were used: matching to a stimulus, matching without a stimulus, identification of a symbol name, recognition of symbols, and the oral or written production of symbols named. Items in 1, 2, and 3, required the subject to identify a symbol from eight choices. The seven alternatives represented specific kinds of perception errors. Two forms, A and B, each testing different sets of symbols, were included in each test. High reliability was established.

Results and Conclusions: A four-way analysis of variance design was utilized to study the effect of the differences in the variables of grade, sex, type of school, the form taken on each test, and the interaction of these variables. Pearson Product Moment Correlation Coefficients were obtained for the scores obtained in a sub-study of 76 subjects on each test and the factors of chronological age, numbers of years using braille, and intelligence (Interim Hayes-Binet Intelligence Test). All correlations were positive and increased in significance in the more difficult tests. The number of years using braille proved to be a more significant factor than chronological age or intelligence. For 82 subjects, Spearman Bank Order Correlation Coefficients were established between the total score obtained in all five modes of presentation, and score on the Word Meaning (.57) and the Paragraph Meaning (.64) tests of the Stanford Achievement Test. No significant difference was found between the

oral and written responses to the reproduction of the letters named. A study of the relative difficulty of the five modes of presentation indicated that models 1 and 5 were the easier tests for all grades. Symbols tended to have the same level of difficulty in all modes of presentation. Some inherent factor within the symbol itself seems to determine its legibility.

Martin, C. J., and Alonzo, L. (1967). Comprehension of full length and telegraphic materials among blind children. (Final report-Project No. R6-1179, Grant No. 32-32-0410-6004). Educational Research Series, No. 42, Michigan State University, East Lansing, MI.

Purpose: To determine whether braille material presented in telegraphic style can be learned as effectively as material presented in conventional style.

Subjects: 210 pupils from grades 6-9 who had read braille for four years or more.

Procedure: One third of subjects read a traditional passage, one third read a medium length telegraphic version, and one third read a short telegraphic version. Each group was tested in the following ways: (a) for retention and distortion of set relations, (b) with multiple choice items calling for retention of the important events, settings and characters in the story, and (c) for ability to reconstruct the story. Identical retests were administered after one week.

Results:

1. Subjects reading the medium and short telegraphic versions required significantly less time to read than subjects reading the traditional version.

2. The reading rates (wpm) of subjects reading the short telegraphic version was significantly slower (40%) than that of those reading the traditional version.

3. There was little difference among the groups in amount of recall immediately and after one week.

Foulke, E., and Warm, J. (1968). The development of an expanded reading code. University of Louisville, Louisville, KY.

Purpose: To evaluate the effectiveness of an expanded braille matrix.

Procedure: A slate arranged on a double screw assembly that allowed for almost infinite lateral and vertical adjustments was used. The slate could be used to emboss on paper, plastic and sheet metal. In some experiments the sheets were bound together in booklets. In others, dots were embossed on aluminum and mounted on blocks. Subjects were required to match symbols embossed on the aluminum while the device was placed behind a curtain. A tachistotactometer was used to stimulate the sense of touch, but it lacked the "feel" of reading movement. Therefore, a 16 mm tape embossed with dot patterns was used. This tape was designed to have a continuously variable speed. Legibility of a dot pattern was determined by determining the speed at which the pattern was readable.

Results and Conclusions: Research was still in progress, and there was no analysis of data to report. However, inspection of data already collected suggested that experienced braille readers readily learn to discriminate and identify the dot pattern formed in eight and nine dot matrices. One subject had been given sentences to read which contained nouns, adjectives, and verbs paired with the two alphabets of dot patterns. He could read those sentences more rapidly when they were written in the new alphabets than when they were written in the conventional braille alphabet.

Flanigan, P. J., and Joslin, E. S. (1969). Patterns of response in the perception of braille configurations. New Outlook for the Blind, 63, 232-244.

Purposes:

1. To determine the relationship between stimulus presentation and response

2. To determine the effect of a remediation program on this relationship

3. To determine the speed of reading standard braille materials

4. To determine the length of the interval between stimulus and response

5. To rank order difficulty in letter perception

Subjects: 27 students randomly chosen from a residential school for the blind, ranging in age from 9 to 17 in grades 3 to 9 and IQ's from 65 to 144.

Procedure: A tachistoscoptic device and standard braille reading material were used in the following procedures.

In phase 1 subjects were given 10 fifteen minute trials with letter sequence and rate of presentation varied to determine rank order of difficulty and relationship between stimulus presentation time and error rate. In phase 2 subjects were given 15 nine minute trials in which the same configuration was represented until a total of 10 presentations of the configurations had occurred. Phase 2 was used to determine the effects of remediation.

Results and Conclusions: Optimal speed of presentation, as measured by error rate, was .06 second. The trend of errors increasing in proportion to the faster presentation time seems to indicate perception speed parameters. For younger braille readers there appears to be a correlation between IQ and errors made at the optimal speed. Ranking of the 17 most difficult configurations was at variance with the other studies of difficulty rankings. Haptic mode of response seems to confirm that the difficulty lies in reversible cells and cells containing four or more dots. It was hypothesized that the difficulty is in braille's lack of varied character form.

Lowenfeld, B., Abel, G. L., & Hatlen, P. H. (1969). Blind Children Learn to Read. Springfield, IL: Charles C. Thomas.

Purpose: The purposes of the study reported in the book are (a) to explore the status of braille reading instruction of children in local day school programs and residential schools and (b) to determine the reading rate and reading comprehension of children who were braille readers.

Subjects: 200 students in grades 4 and 8 in both residential and day school programs.

Procedure: To achieve the first goal of the study, 382 questionnaires were sent to public and residential schools requesting information about methods of instruction and materials used. Three-hundred and sixty-two questionnaires completed by 520 teachers were returned. Specific information related to questions asked will be presented in the results section of this abstract. To achieve the second goal of the study, a total of 200 students in grades 4 and 8 were tested for reading rate and comprehension. The students were enrolled in both residential and local day school programs.

Results and Conclusions: The responses from teachers on methods of instruction and materials used provided the following information:

1. The majority of teachers in both local and residential schools began braille reading instruction in the first grade.

2. The majority of teachers in both residential and local day schools began reading instruction with whole words and/or meaningful sentences.

3. Almost all teachers began instruction using grade 2 braille.

4. The majority of teachers in both educational settings encouraged the use of both hands in braille reading.

5. About half of the teachers in both settings gave consideration to the use of the right or left hand in reading braille.

6. Teachers in residential schools encouraged the use of the index fingers of the left and right hands for reading, but teachers in local day schools encouraged the use of two, three, or four fingers.

7. The majority of teachers in both settings indicated that braille writing was begun at the same time as reading instruction shortly after reading instruction began.

Responses to questions related to the use of materials in teaching braille reading indicated that a variety of commercially transcribed reading textbooks were used to teach braille reading and that the braillewriter was almost always used to introduce braille writing.

The results of the testing of the students which related to reading behavior indicated that:

1. More than 70% used both hands in reading, 20% used the right hand and 10% used the left hand.

2. Of the students using both hands, half used the left hand to find the next line and one-fourth read with both hands moving in "parallel" motion.

3. More than 60% of the readers read with their index fingers.

4. Most students held their books approximately parallel while reading.

5. Eighth graders were less likely to rub or retrace letters.

6. Most students showed no mannerisms while reading, especially eighth graders.

7. Most students were not avid readers.

Results of the study related to comprehension and reading speed were as follows:

1. Results from the Sequential Tests of Educational Placement (STEP Tests) and Stanford Achievement Tests (SAT) showed that the reading comprehension of blind children in local day schools was equal to that of their seeing peers and that of residential schools was slightly below that of seeing children. It should be noted that

the blind children in this sample were older than normal for their grade placement and that they were in the higher range of intelligence as indicated by IQ tests given at the beginning of the study.

2. The mean reading rates for fourth graders was 83.75 wpm for local day schools and 71.60 wpm for residential schools. For eighth graders, the mean reading rate in local day schools was 149.22 wpm and 110.44 wpm for residential schools.

Again, the higher IQ levels and Chronological age of blind subjects must be considered in interpreting these results.

Nolan, C. Y., & Kederis, C. J. (1969). Perceptual factors in braille word recognition. New York: American Foundation for the Blind.

Purpose: This publication consists of descriptions of nine research studies related to the braille system as a communication process.

Procedure: Each of the nine studies are described below, with the purpose, procedure and results of each.

Study I: Legibility of Single-Cell Characters

Purpose: To establish the relative legibility of the 55 braille characters that stand for letters or small letter groups in Standard English braille.

Subjects: The 36 residential school subjects included two boys and two girls selected randomly from students in each of grades 4 through 12 whose reading achievement was at the fourth grade level or greater.

Procedure: The braille characters were randomly presented until each subject correctly identified each character. The technique used was the ascending series of the method of limits, with each character being exposed initially for a period of .01 sec. Exposure times were increased in .01-sec. steps thereafter until correct recognition occurred.

Results:

1. The braille characters differed significantly in the man times required for recognition.

2. The order of legibility for characters found agreed more closely with that previously established by the Uniform Type Committee (r=.68) than that order found by Burklen (r=.48).

3. Character recognition time is positively related to the number of dots in the character.

4. Within groups of characters having the same number of dots, those characters with dots most widely dispersed have the shortest recognition times.

5. Characters whose dots fall in the lower two rows of the braille cell require 55% more time for recognition than identical characters whose dots fall in the top two rows.

6. Sixty percent of the erroneous responses to the stimulus characters involved naming a character similar in shape to the stimulus.

7. Missed dot errors were responsible for 86% of the incorrect responses.

8. Dots falling toward the bottom of the braille cell were missed more frequently than those falling at the top.

9. The order of legibility of the characters was correlated (r=.46) with the order of their frequency of occurrence in print.

Study II: Effects of Word Length, Familiarity, and Orthography on Recognition Thresholds for Braille Words

Purpose: To compare effects of word length, familiarity, and orthography on the thresholds for word recognition by groups of fast and slow readers and to study the relationships between the recognition thresholds for braille words and those for the characters of which they are composed.

Subjects: High school students from four residential schools for the blind who read braille with above average comprehension were ranked from fast to slow on a measure of reading speed. Fifteen students were randomly selected from each of the upper and lower thirds of this distribution to comprise the fast and slow reading groups for this study.

Procedure: A multivariate design was used to compare the recognition thresholds for 36 braille words that differed in length (3, 5, and 7 characters), familiarity (frequent x infrequent occurrence in print), and orthography (no contractions x contractions). The words were presented in random order under conditions of systematically increasing times of exposure until each subject was able to recognize correctly each word.

Results:

1. Recognition times for words increased as they became longer and less familiar and contained contracted braille forms.

2. The effects on word recognition, times of increase in word length and decrease in familiarity augmented one another.

3. Orthography interacted differentially with the familiarity variable in that for familiar words, contracted words had the shortest recognition times, while for unfamiliar words, uncontracted words had the shortest recognition times.

4. The effects of this interaction were augmented with the increasing length of the words studied.

5. Fast readers recognized words in significantly less time than slow readers.

6. The single and combined effects of the variable studied were proportionately greater for slow readers.

7. Fast readers recognized individual braille characters in significantly shorter times than did slow readers.

8. The order of legibility of braille characters was the same for fast and slow readers (r=.80).

9. Generally, the exposure time required for word recognition was longer than the exposure time necessary to feel all the characters in a word (cover time). Both these times were longer than the sums of the recognition times for the individual braille character (synthetic recognition times) which made up each word.

10. Synthetic recognition times were directly related to word length, but no other variable.

11. The ratio of recognition time to cover time decreased as words grew longer and contained contractions. However, this ratio increased as words become less familiar.

12. Ten percent of the total 1,080 word recognitions required in the study occurred at exposure times which were too brief to allow the subjects to feel all the characters in the word.

13. Recognition of words before all characters were felt rarely occurred for unfamiliar words or three character

words. The frequency of occurrence of this phenomenon was positively related to the number of characters in words.

14. Faster readers recognized 20% more words before all characters were felt than did slow readers.

15. Fast and slow reading groups did not appear to differ with respect to the types of errors made.

16. Fast readers appeared to differ in IQ from slow readers.

Study III: Influence of the Number of Dots and the Position of Dots on Recognition Thresholds for Braille Words

Purpose: To establish the relationship between the number of dots in a braille word and its recognition time. To study the influence of the presence or absence of contractions within words upon variations in the number and the position of dots within words. To compare groups of fast and slow readers on measures of IQ and tactual sensitivity.

Subjects: Fifteen fast and 15 slow braille readers at the high school level in 3 residential schools who were selected as described for Study II.

Procedure: A multivariate design was used to compare recognition thresholds of groups of fast and slow readers for braille words that varied in the number of dots contained (varied through 5 steps of 2 dots each from 11 through 19), in the position of dots within words (varied between words with a preponderance of dots in the upper part and words with dots evenly distributed), and in orthography (varied between contracted and uncontracted words). Words were equated for familiarity and length. Method of presentation was similar to that for Study II. Measures of IQ were obtained from school records and each subject was given the Roughness Discrimination Test.

Results:

1. The mean IQ for the fast reading group was found to be 20 points higher than that of the slow group; however, no difference in tactile discrimination existed between the groups.

2. While the number of dots in a word appeared to be a significant variable, no systematic pattern for this effect could be established.

3. Words with the preponderance of braille dots falling in the upper part were easier to recognize than words with dots more evenly distributed.

4. Fast readers found words containing contractions easiest to recognize, while slow readers found words without contractions easiest.

5. The number of dots within a word, the position of dots within a word, and the presence or absence of contractions within a word were significantly related; however, no clear-cut patterns of relationship were discernible.

Study IV: Influence of Braille Contractions upon Recognition Thresholds for Words

Purpose: To determine the effects of number of contractions within words, the position of contractions within words, and the position of contractions within the braille cell upon the recognition thresholds for familiar and unfamiliar words.

Subjects: Twenty braille readers from grades 9 through 12 who were randomly selected from among 55 such students enrolled in two residential schools for the blind.

Procedure: A multivariate design was used to compare recognition thresholds for braille words that varied with respect to number of contractions (one or two), type of contraction (contractions with dots falling in all three rows or contractions with dots falling only in the lower two rows of the braille cell), position of contractions (varied to include words with contractions falling in the initial, middle, and final part of the word), and familiarity (varied between familiar and unfamiliar words). Procedures for establishing recognition thresholds duplicated those of Study II. The number of dots and number of character in the words were equated.

Results:

1. Recognition times for familiar words were shorter than those for unfamiliar words.

2. Correlation between IQ and mean word recognition time for subjects was .57.

3. The effects of the three contraction factors studied varied complexly with each other and the familiarity factor. Some of these interactions were

   (a) As the number of contractions increased from one to two, recognition of familiar words became easier and that of unfamiliar words more difficult.

   (b) Familiar words with lower contractions were easier to recognize than familiar words with contractions having dots in all rows of the braille cell. The reverse was true for unfamiliar words.

   (c) Familiar words with contractions occurring in their initial parts were easiest to recognize, while unfamiliar words with contractions falling in their final parts were easiest.

Study V: Effects of Context upon Recognition Thresholds for Braille Words That Vary in Length, Familiarity, and Orthography

Purpose: Because the words in studies II through IV had been exposed in isolation, the question arose whether similar effects would result if the words were exposed within the context of sentence structure. This study attempted to answer this question.

Subjects: Fifteen fast and 15 slow braille readers from 3 residential schools were selected exactly as were those subjects in Study II.

Procedure: This study duplicated Study II with the exception that each stimulus word served as the terminal word in a sentence presented auditorily to subjects immediately preceding exposure of the stimulus word.

Results:

1. Fast readers differed from slow readers by about 20 IQ points.

2. Fast readers recognized words in significantly shorter exposure times than did slow readers.

3. The effects of changes in word length, familiarity, and orthography upon word recognition thresholds when words were exposed in context were similar to those found in Study II for words exposed in isolation.

4. Variation of these factors singly and in combination resulted in proportionately greater increases in word recognition times for slow as compared to fast readers. Similar results occurred in Study II.

5. In comparison to recognition times established in Study II, context reduced the times necessary for recognition of familiar words and increased those of unfamiliar words.

6. The longer the word, the greater the effects described in item 5 above.

7. In comparison to fast readers, the effects for slow readers of context decreasing reading times for familiar words were much less and the effects of context increasing reading times for unfamiliar words were much greater.

8. For familiar words, the effects of context in reduction of recognition times was much greater for contracted words than for uncontracted words.

9. The presence of context increased the number of words recognized before all characters were sensed from the 10% found in Study II to 19%; however, these shifts were restricted to the words of 5 and 7 characters.

Study VI: Effects of Context Occurring in Continuous Text on Reading Times for the Stimulus Words of Study II

Purpose: To study the effects of variations in word length, familiarity, and orthography on reading times for the braille words when they were read within the context of a continuous story.

Subjects: Thirteen fast and 13 slow braille readers from grades 9 through 12 of one residential school who were selected in a manner similar to that of Study II.

Procedure: A short story was written which contained all the stimulus words of Study II. The oral reading of the story was taped for each subject. These recordings were expanded in time by 185%. The time for reading each stimulus word was then measured with an ordinary stop watch.

Results:

1. The average IQ of fast readers exceeded that of slow readers by about 15 points.

2. The effects of variation in word length, familiarity, and orthography on reading times for braille words were similar to those found in Study II, with 3 exceptions:

   (a) In Study II the increase in recognition times of words with increases in length appeared to be positively accelerated for all types of orthography. In this study the curve for recognition times of uncontracted words with increases in length appeared to be negatively accelerated.

   (b) In this study, a differential reaction to unfamiliar contracted words occurred for the groups of fast and slow readers. Slow readers required considerably more time to read unfamiliar words than did fast. Also, slow readers required more time to read the contracted unfamiliar as compared with the uncontracted than did fast readers.

   (c) In Study II the familiar contracted words were recognized in less time than their uncontracted counterparts while among unfamiliar words, contracted words required greater times. In the present study in almost all cases contracted words required longer reading times than uncontracted words.

Study VII: Effects of Familiarity, Length, and Orthography of Braille Words on Their Recognition Thresholds at the Elementary School Level

Purpose: To compare the effects of variations in length, familiarity, and orthography upon the recognition threshold for braille words for groups of elementary and high school readers.

Subjects: The subjects of Study II and 15 fast and 15 slow braille readers in grades 4 through 6 of three residential schools who were selected in the same manner as the subjects in Study II.

Procedure: The procedure was identical with that of Study II.

Results: The results for elementary readers duplicate those of Study II for high school readers with the following exceptions:

1. No IQ differences were found among groups of fast and slow elementary braille readers.

2. For elementary readers the correlation of IQ with reading rate was -.09 and the correlation of IQ with comprehension was .35.

3. Word recognition times were much longer for elementary grade readers than for high school readers.

4. Variations in word length and familiarity caused disproportionate greater variations in the word recognition times for elementary readers when compared to high school readers.

5. Augmentation of word recognition times resulting in the combined variation of the factors word length and familiarity was much greater for elementary than for high school readers.

6. For unfamiliar words the shift from uncontracted to contracted orthography resulted in much greater increases in word recognition times for elementary as compared to high school readers.

7. The differences in recognition times for familiar and unfamiliar words were proportionately greater between fast and slow high school readers than between fast and slow elementary school readers.

8. Elementary level readers required significantly greater time to recognize braille characters than did high school readers, although the correlation between the orders of legibility for the two groups was .78.

9. Groups of fast and slow high school readers differed significantly in character recognition times while groups of fast and slow elementary school readers did not.

10. Elementary readers appeared to make more errors in recognition of contracted characters than did high school readers.

Study VIII: Braille Word Recognition by Readers of Low Intelligence

Purpose: To compare the thresholds for recognition of braille words of groups of low IQ readers from elementary and high schools with those of similar groups of readers of average and above IQ.

Subjects: The subjects of studies II and VII, plus 15 elementary (grades 4 through 6) and 15 high school readers from three residential schools. All subjects had IQ scores of 85 or under and showed moderate reading comprehension. The "high school" group was composed of readers of high school age, many of whom were retarded in grade placement.

Procedure: The procedure was identical to that of studies II and VII.

Results:

1. Low IQ readers as defined by the study comprised 30% of the enrollment of the three schools in the elementary grades and 20% of the high school enrollment.

2. Mean reading speeds of low IQ readers were the same for elementary and high school groups (50 wpm).

3. There were no significant differences between word recognition times for groups of low IQ elementary and high school readers.

4. Low IQ readers from the elementary grades required 33% more time to recognize words than the normal students of Study VII, while low IQ readers in the high school group required 111% more time to recognize words than the normals in Study II.

5. Variations in word length, familiarity, and orthography produced effects in word recognition times for low IQ readers similar to those for normal readers.

6. Contracted words of all types were more difficult for low IQ readers, while normals found contracted familiar words easier to recognize than uncontracted familiar words.

7. The almost total lack of interaction among the factors studied implies that low IQ readers failed to use invariant relationships among the factors as cues for word recognition as done by normal readers.

8. No differences in mean times required for recognition of individual braille characters were found between groups of low IQ elementary and high school readers.

9. No differences in mean character recognition times were found between groups of low IQ and normal elementary readers; however, low IQ high school readers required 89% more time than normal to recognize characters than normal high school readers.

10. The differences between recognition times for words and the sum of recognition times for characters within words varied greatly between groups of low IQ and normal readers. These differences for elementary readers were normal, .64 sec and low IQ, 1.15 sec; for high school readers the differences were normal, .42 sec and low IQ, .98 sec.

11. With respect to recognition of words before all characters were sensed, normal elementary readers exceeded low IQ by 23% and normal high school readers exceeded low IQ by 3%.

Study IX: Effect of Character Recognition Training on Braille Reading

Purpose: To determine the effects of training for speed and accuracy in braille character recognition on the efficiency of the total reading process.

Subjects: Two groups of 12 subjects each were selected from grades 3 through 6 of a residential school. The groups were composed so that they were equated for sex, mean grade, age, IQ, and reading achievement.

Procedure: The two groups were pretested on silent reading speed and comprehension, oral reading speed and errors, and character recognition speed and errors. The group selected as experimental then received training in character recognition for 18 consecutive school days. Equivalent posttests of all pretested measures were then obtained.

Results:

1. Following training, the experimental group, when compared with the control, demonstrated significant decreases in time for character recognition, improved accuracy in character recognition, increased oral reading rates, and decreased oral reading errors.

2. Nonsignificant differences favoring the experimentals were found for increased silent reading rates and increased silent reading comprehension.

Research on the Braille Codes
1970-1979

1970-1979

The volume of research on the braille codes decreased somewhat during this decade but there were several studies which were particularly important in relation to the provision of special curricular materials for children who use braille as their learning medium. Some of these were the studies by Rex (1970), Umsted (1972), Gill (1978) and Mangold (1978), Caton and Pester (1979).

Evaluation. The studies cited above were carefully done and have few methodology faults except for numbers of subjects and representativeness of the sample. A number of studies on the rapid reading of braille were conducted during this period which are of doubtful validity. This emphasis on rapid reading was short-lived although some aspects of the techniques such as moving rapidly across a line with both hands are still retained in some training programs. The study which compared rapid speech and braille (Bixler and Foulke, 1972) was one of a number of important studies related to the comprehension of rapid speech.

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Abstracts of Braille Studies
1970-1979

Rex, E. J. (1970). A study of basal readers and experimental supplementary instructional materials for teaching primary reading in braille. Doctoral Dissertation, Nashville, TN: Peabody College, Vanderbilt University.

Purposes:

1. To analyze braille features in materials presently used for the teaching of reading to blind children.

2. To develop supplementary instructional reading materials for use with blind children.

3. To conduct a pilot study of the effectiveness of the supplementary instructional materials.

Subjects: 27 subjects were assigned to experimental and control groups. There were 16 subjects in the experimental group and 11 in the control group. Pretest and post test scores were obtained on all subjects using standardized achievement tests.

Procedure: Four of the most frequently adopted basal reader series were analyzed in terms of the use of contractions in the braille translation. Vocabulary lists at seven reading levels (preprimer through third) were analyzed for the appearance of all contractions. For purposes of the analysis, contracted words were classified in these braille orthographic categories: initial use, rate of introduction, frequency of appearance, and commonality among the four basal readers.

Information derived from the basal reader analysis was used to develop supplementary materials. The supplementary materials were based on principles of linear programmed instruction. The materials were constructed in terms of braille symbols grouped into four categories derived from the basal reader analysis.

Results and Conclusions: The study of basal readers revealed 87% of the braille contractions and short form words were introduced by the end of the third grade in the four basal reader series. The number of contractions introduced in a series ranged from 136 to 152. Of the 165 different contractions introduced in the four series 131 or 69% were common to all four series. Fourteen contractions had use in only one basal reader series. There was remarkable similarity among the four series in terms of new contractions introduced and the number of contracted words in

the vocabulary. In the classification of contractions by category, it was revealed that contractions in the more difficult categories were introduced more slowly and at higher levels of reading and had less commonality among the series.

An exploratory study of the effectiveness of the supplementary materials was carried out. The control group was given reading instruction with the basal reading series and supplementary material normally used by the school. The experimental group used the standard basal series and the supplementary materials.

Gain scores of the experimental group exceeded those of the control group on three of the four criteria measured. However, the differences in the mean scores of the two groups on pretest and post test were not statistically significant on any of the four criteria measured.

Harley, R. K., & Rawls, R. F. (1971). Comparison of several approaches for teaching braille reading to blind children. AFB Research Bulletin, 23, 63-91.

Purpose: To determine the most effective approach to the teaching of beginning reading to children who will use braille as their reading medium.

Subjects: Subjects were between five and ten years of age with vision ranging from 20/200 to total blindness. Their intellectual ability ranged from mildly retarded to high average.

Procedure: A comparison of Grade 1 Braille and Grade 2 Braille and phonemic Braille media in two basal readers was made. Analytic and synthetic approaches were used to compare the basal readers.

Results and Conclusions: Phonemic braille could be used successfully with beginning braille readers. The analytic approach appeared to function more effectively with the phonemic materials than the synthetic approach. The effectiveness of grade 1 and grade 2 braille approaches was not adequately measured. The authors state that a more extensive study with more subjects, more adequate materials and of longer duration is necessary before any conclusions and generalizations can be made.

Russell, H. K. (1971). The effect of order of presentation on the programmed learning of braille. Dissertation Abstracts International, 31, 503B (University Microfilms No. 71-4420)

Purpose: To study the effects of various orders of presentation of braille characters when presented in a programmed method of instruction which includes both a tactual and auditory presentation of the materials.

Subjects: Data on subjects were not given.

Procedures: The Roughness Discrimination Test, Army General Classification Test, and the Minnesota Multiphasic Personality Inventory were used. The first temporal arrangement considered was similar to that found in classical conditioning experiments in which Stimulus 1 (the braille character) precedes Stimulus 2 (the auditory explanation) by a short interval. The second condition required that both stimuli be presented simultaneously; and the third order of presentation was a reversal of the first. One additional condition was utilized in which Stimulus 1 was presented with the absence of Stimulus 2. This was a control condition to insure equal tactual familiarity.

Results and Conclusions: Analysis of the results suggested a trend, although not significant, favoring short forward-conditioning. There were no differences between the groups in their ability to retain the braille material over a 24 hour period, suggesting that once a skill is acquired to a certain criterion the ability to retain the skill is constant over subjects.

The Roughness Discrimination Test was not able to predict ability to learn braille when used with non-blind normal subjects. Intelligence, as expected, appeared to have a positive relationship to learning braille.

An attempt was made to relate various personality characteristics with other demographic variables. Some relationships were significant although a more exact explanation must wait for further experimentation.

Bixler, R., Foulke, E., Amser, C., & Nolan, C. (1972). Comprehension of rapid speech. Louisville, KY: University of Louisville.

Purpose: To measure the comprehension of blind children as a function of word rate and of the kind of material read. Also, to compare comprehension levels obtained at various word rates with that obtained when the same material is read in braille.

Subjects: Two hundred ninety-one braille readers in the sixth, seventh, and eighth grades in eleven residential schools for the blind in the eastern U.S. (ninety-nine public school children were used to standardize the test questions).

Procedure: Selections of literary and scientific materials were presented to the subjects in braille and auditorily at words per minute rates of 175, 225, and 325. The subjects were divided into six groups. One group was tested on the material without an opportunity to read it to establish a baseline for errors and comprehension. The other five groups, none of whom had been exposed to compressed speech prior to the experiment, heard the two selections at differing rates of speed or used the brailled copies. Immediately after the selections the subjects were tested for comprehension in braille (multiple-choice test). To select items for the test, an item analysis was completed. Two criteria, item difficulty and internal consistency, were employed for elimination of unsatisfactory items. Those items passed by fewer than 15% or more than 85% were discarded. Any item whose correlation with total test score yielded a phi-coefficient of less than .27 was discarded. Twenty-four items failed to meet these criteria resulting in final tests consisting of 36 items. Split-half reliabilities, corrected by the Spearman-Brown formula, were .80 for the literature test and .75 for the science test.

Results and Conclusions: Results indicated that, for most materials (especially literary materials), listening was more efficient in terms of saving of time, and listening at higher than usual rates of speed did not affect comprehension.

Umsted, R. G. (1972). Improvement of braille reading through code recognition training. New Outlook for the blind, 66, 169-177.

Purpose: To determine whether increasing the speed and accuracy of braille code recognition would positively influence the braille reading process of high school students.

Subjects: 93 subjects in grades 9-12 at state residential schools for the blind in Indiana, Iowa, and Kentucky. Each student had read braille for a minimum of three years and could not read print.

Procedures: The subjects were given Form A of a diagnostic reading test and a week later Form B Monetary rewards were given for the best improvement in performance over the preceding week. The second test was used to establish high, medium, and low reading rate levels. Subjects were divided into thirty-six experimental and thirty-six controls. The experimentals were given fifteen 1/2 hour sessions of individual training on the Braille Code Recognition List and silent reading. At the end of the training period another reading speed and comprehension test was administered.

Results and Conclusions: It appeared that training for accuracy and increased speed in braille code recognition did not have any appreciable effect on the scores of the silent reading post test. However, the experimental group did show a thirty percent gain in silent reading speed. The low reading level group showed a sixty percent gain in the number of words read per minute, and the medium reading level gained by thirty-three percent.

This study demonstrated that special instruction to increase speed and accuracy of recognition of the braille code could definitely influence the reading of high school braille readers.

Paska, V., & Finding, J. (1973). The "perfect" braille system. AFB Research Bulletin, 26, 135-138.

Purpose: To remodel the Danish Grade 2 Braille system, saving as many characters as possible but utilizing a high degree of simplicity.

Subjects: None

Procedure: More than 4000 of the most commonly used words in the Danish language were entered into a computer. Then, a lengthy book was entered into the computer in Grade 1 Braille. Several programs were run to count character savings and ease of whole word and half word abbreviations and to look for all two letter combinations, counting the values assigned.

Results and Conclusions: According to this study, the "perfect" braille system is obtained by the following rules:

1. Use approximately 100 full word contractions.

2. Use approximately 30 half-word contractions.

3. Minimize rules and exceptions.

4. Don't use contraction sign.

5. Use Braille Grade 1 whenever helpful or necessary.

Wallace, D. H. (1973). The effect of rapid reading instruction and recognition training on the reading rate and comprehension of adult legally blind print and braille readers. Unpublished doctoral dissertation, Brigham Young University, Utah.

Purpose: To investigate the effect of rapid reading instruction and recognition training on the reading rate and comprehension of adult legally blind print and braille readers.

Subjects: 60 legally blind adults were assigned to three groups. Assignment to groups was based on sex and degree of vision. Two groups received the experimental treatments and one group was the control group.

Procedure: The Diagnostic Reading Test Survey Section A & B were used as the pre and post tests. The braille readers used thermoform copies of the test and the print readers' tests were typed in fourteen point type. Several stories of elementary, junior high and adult fiction levels were used for training purposes. One experimental group received rapid reading training only and one received rapid reading and recognition training.

Each subject had six training sessions spread over two or three weeks. Each subject was told to spend an extra hour practicing at home after each training session. The recognition skills were taken from Umsted's (1970) Braille Code Exercises. Comprehension and reading rate scores were calculated for each group.

Results and Conclusions: There was a significant increase in the reading rate of the two experimental groups over the control group. The rapid reading group showed a trend for greater increase in reading rate than the rapid reading and recognition group. The print readers had a greater increase in rate than the braille readers. It appeared that the rapid reading instruction, with or without recognition training significantly increased the reading rate of legally blind adults with rapid reading instruction giving a slightly greater increase.

Kusajima, T. (1974). Visual reading and braille reading: An experimental investigation of the physiology and psychology of visual and tactual reading. New York: American Foundation for the Blind.

Purpose: To determine the functional differentiation of the fingers while reading braille.

Subjects: 164 students from the Tokyo School for the Blind, including both boys and girls ranging in age from ten to twenty-three. Some were totally blind and some had residual vision.

Procedure: Easy reading material on summer and winter themes (No specific source given). A tactual recorder fastened to the reading finger(s) and a roll of smoked paper on a cymograph. The subjects were asked to read with one or both hands and their finger movements were recorded on the paper drum.

Results and Conclusions: The fingers were found to run in exact parallel to each other, disproving the difference of function theories. The author found that the different fingers did not have different functions and that each finger was capable of reading alone. The two handed readers' second finger helped in perception and corrected the perception of the characters or words.

Schale, F. (1974). Teaching the blind rapid reading of braille. Unpublished manuscript. Chicago, IL: Northwestern University.

Purpose: To develop increased rate and comprehension in the reading of the totally blind who read grade 2 braille.

Subjects: Thirty blind students were divided into experimental and control groups. Most had graduated from high school, 1/3 were non-white, slightly more than 1/3 were male and most had normal intelligence or above.

Procedure: Subjects read selections from The New Reader's Digest Skillbuilders, Level VI. Forms A and C of the survey section of the Diagnostic Reading Tests, 7-12 were used for the pre and post tests. They received 20 hours of instruction in rapid reading. This instruction consisted of a reinforced reading method which combined Gestalt and reinforcement theories of instruction.

Results and Conclusions: Reading rates and comprehension scores were compared for all groups. The experimental group read ten times faster with twenty percent better comprehension than the control group. The control group made no significant progress in rate, but improved five percent in comprehension. These results seem to indicate that training in rapid reading of braille increases both speed and comprehension.

On the standardized DRT the experimental group read approximately seven times faster with eleven percent better comprehension; whereas the control group read over two times faster with 9% better comprehension. T-tests indicated that the experimental group's difference in rate was significant at the .01% level of confidence and in comprehension at the 5% level. In contrast the differences in rate for the control group was significant at the 5% level, but not for comprehension.

Tuttle, D. W. (1974). A comparison of three reading media for the blind: braille, normal recording, and compressed speech. AFB Research Bulletin, 27, 217-230.

Purpose: To compare the reading of braille with normal recorded material and material recorded in compressed speech.

Subjects: 100 students ages 14 through 21 attending school in California. All subjects were braille readers.

Procedure: The Reading Versatility Test (Intermediate Level) was given in all three forms. Subjects were given an introduction to reading by compressed speech then given the three forms of the RVT. An index of efficiency was derived by dividing the total reading times by the time spent reading each section.

Results and Conclusions:

1. No difference in comprehension of the three forms was found.

2. Braille took almost twice as long as listening to normal recording and three times as long as compressed speech.

3. At every level of performance compressed speech was more efficient than either Braille or normal recording.

4. For the whole sample, compressed speech was more efficient than normal recording which in turn was more efficient than braille.

Mommers, M. H. C. (1975). Some factors related to braille reading by blind children in elementary schools. Nijmegen, Netherlands: Institute for Educational Sciences Katholicke Universitat.

Purpose: To standardize a number of braille reading tests for elementary schools. Variables also considered were: (a) verbal IQ, (b) haptic perception, (c) residual vision, and (d) the manner in which the subject behaved while reading.

Subjects: The entire blind population of Holland without additional handicaps in the age range six to fifteen. The total number of subjects was one hundred twenty.

Procedure: The following tests were standardized on this population between 1970 and 1973:

1. Speed Test of Braille Words (SBW)
2. Braille Sentences Reading Tests (BZL)
3. Power Test for Braille Words (MLB)
4. Stilles Test of Reading Comprehension, Forms 3, 4, and 6.

All tests were in grade 1 braille since contracted braille is used only by older students for note taking and rarely for reading.

Results and Conclusions:

1. The reading speed of separate words by sighted students is at least two or three times faster than the speed of blind pupils. However, the differences in relation to reading power and reading comprehension are much slighter.
2. Poor Braille readers usually lie further behind the poor sighted readers than the good braille readers lie behind good sighted readers. This fact reinforces Nolan and Kederis' (1969) assumption that the intellectual cut off point for serious consideration of reading as an educational vehicle may be much higher for braille than for print.
3. The technical reading skills continue to develop until fifteen years of age (or older) with good as well as poor braille readers.

4. The degree of blindness as operationalized by the variables of residual vision, age of onset of blindness, and space orientation shows little or no relation to the reading achievement of the subjects in this study.

5. The variable touch shows a substantial relationship with reading achievement.

6. There is a clear connection between the verbal IQ as measured by the Wechsler Intelligence Scale for Children and reading achievement.

7. The relationship between haptic perception and reading achievement is less than that between verbal IQ and reading. Haptic form discrimination and haptic figure orientation are more closely related to reading than haptic size and roughness discrimination.

Schale, F. (1975). Teaching the blind rapid reading of braille, Phase II. Chicago, IL: Northwestern University.

Purpose: To double the rates of reading and develop skimming skills (without loss of comprehension) for the blind as they read standard level brailled exercises.

Subjects: Experimental and control groups comprised of 17 blind subjects. Most were high school graduates, about one-third were non-white, slightly more were male, and most had normal intelligence.

Procedure: The writer's Rapid Reading Kit was transcribed into braille. It consisted of thirty-two exercises and instruction which accompany Maltz's Psycho-Cybernetics (9th grade level equivalency). Some college level articles were also used.

The pretests and posttests were the braille Forms A, B, and C of the standardized Nelson-Denny Reading Tests for grades 9-16. Informal testing was also used for the pretests and posttests.

The 2R (Reinforced Reading) method which combines gestalt and reinforcement theories of learning was used during the twenty hours of instruction the experimental group received. The control group received no instruction.

Results and Conclusions: Experimental and control subjects' reading rates and comprehension scores were compared in percentages or percentile ranks and with T-tests. On the reinforced reading manual exercises, the control group made slight progress in rate (barely reaching the .05 level of significance) and had no significant gain in comprehension. On the other hand, the experimental group read almost seven times faster with better comprehension. The experimental group maintained these results on a two and one half month follow-up test.

Howell, G. C. (1977). A comparison of pacing and freehand rapid reading instruction in braille on reading rate and comprehension of school age blind children. Dissertation Abstracts International, 38, 202 a. University Microfiche No. 77-13,802.

Purpose: To determine the effects of pacing and freehand methods of rapid reading instruction in braille on measures of reading rate and comprehension. In addition, to determine the effect of rapid reading training on their hemispheric electroencephalogram patterns.

Subjects: 24 school age blind students.

Procedure: Subjects were assigned to two experimental groups and one control group. One experimental group used a "pacing" technique in which the reading process was controlled or "paced," the second control group used a "freehand" technique in which there was no such control. The control group read in the normal manner. An analysis of covariance was performed using gain scores in reading rate, comprehension, and EEG change patterns relative to methods of instruction, IQ and sex.

Results and Conclusions: A significant increase in the reading rates of the two experimental groups over the control group was found, with the pacing group indicating a trend for a slightly greater increase in reading rate than the freehand group. There was no difference in comprehension or hemispheric dominance among the three treatment groups. It was concluded that either method of rapid reading instruction could be used to increase significantly the braille reading rates of school age blind children.

Kershman, S. (1976). The validation of a learning hierarchy in tactual discrimination for blind children. Paper presented to Council for Exceptional Children: Chicago, IL.

Purpose: To validate the order of a sequence of tactual discrimination tasks leading to the use of braille and optacon.

Subjects: 60 blind children from grades kindergarten to second grade.

Procedure: Subjects were tested with tasks designed for the readiness level: discrimination of large solid geometric shapes, flat puzzle pieces, embossed dot geometric figures, embossed dot line figures, and raised line segments. These tests culminated with the tactual discrimination of braille figures and of inkprint figures presented on the optacon.

Results and Conclusions: Scalogram analysis of the data supported the hypothesized order of the tasks. Tactual discriminations on the optacon were not beyond the capabilities of most of the 2nd grade children in the study.

Olson, M. R. (1977). The effects of training in rapid reading on the reading rate and comprehension of braille and large print readers. Dissertation Abstracts International, 37, 4287A. (University Microfilms 76-30291).

Purpose: To determine the effects of rapid reading training on the reading rates and comprehension of large print and braille readers. Also, to compare workshops taught by Vearl McBride and two workshops taught by the author.

Subjects: Fifteen braille reading adults, ages 19-62 (mean age of 38.6) composed McBride's group. These adults came from 12 different states and Canada and paid their own tuition. The researcher's first group of braille readers was composed of 12 braille readers aged 10-65 with a mean age of 34.2. The researcher's second group was large print readers ages 10-19 with a mean age of 13.5 years. Both of these groups came from the North Dakota State School for the Blind and surrounding communities at no personal expense.

Procedure: Informal tests and formal tests were given before and after sixteen hours of rapid reading training. The Spache Diagnostic Reading Scales were used.

Results and Conclusions:

1. Reading rate can be significantly increased for braille and large print readers after sixteen hours of rapid reading training without significant change in comprehension.

2. Reading rate on informal tests (no objective measure of comprehension) is significantly greater after rapid reading training than is rate on formal tests.

3. Rates predicted by braille and large print readers before rapid reading training do not significantly differ from rates achieved on informal tests after training.

4. Groups of large print and braille readers, while differing significantly in age, years of education, minutes of practice outside of training, do not differ significantly in their rate increases or changes in comprehension level after rapid reading training.

5. Rate improvements made by braille and large print readers after rapid reading training are not significantly related to their reading rates before training.

6. Rate improvement after rapid reading training is negatively related to age.

7. Reading rate before and after training is negatively related to the number of years a braille reader has previously read print.

8. Rate improvement after rapid reading training is positively related to the use of more than one finger in the reading process.

Wallsten, R. S., & Lambert, R. M. (1977). Visual braille and print reading as a function of display field size. Joint Report from University of North Carolina and Condoria University of Canada.

Purpose: To determine how reading depends on (1) the writing code and (2) the number of characters available simultaneously and (3) on their interaction.

Subjects: 12 experienced visual braille readers who could not read braille tactually. Their mean braille reading experience was 6.5 years and their mean age was twenty. Six subjects were transcribers and were teachers.

Procedure: The SRA Reading Kit for Seniors was transcribed into braille. The braille was produced as black dots on white paper not as raised dots. Typeface was prestige elite. A 2 x 3 test design (writing code by display fields) was used. The fields were all one line high by either 1, 5, or 15 characters wide.

The subjects were divided into two groups, 3 teachers and 3 transcribers to each group. They were timed by an apparatus that held the paper immobile and allowed the subjects to move the window across the page. At the end of each line the apparatus advanced the sheet one line and marked the time. The subjects read 20 paragraphs in a pattern of five print, five braille, five print, five braille or the reverse. Comprehension was checked by having the paragraphs end in mid-sentence and the subjects select the correct ending from four alternatives.

Results and Conclusions: Visual braille reading was slower than visual print reading under all display conditions and benefited only slightly from the simultaneous availability of multiple cells. When reading occurs one character at a time, braille reading is predicted by print reading rate and is unrelated to braille reading experience over two years. However, increased experience does facilitate the simultaneous processing of multiple cells.

Challman, B. E. (1978). Variables influencing the identification of single braille characters. Unpublished master's thesis. University of Louisville: Louisville, KY.

Purpose: To determine if the variables that affected recognition times of braille characters as reported by Nolan and Kederis (1969) would affect recognition times if the subjects had control of the duration of the stimulus.

Subjects: 10 experienced braille readers sixteen to fifty-three years of age whose education level was high school or college. The amount of reading practice varied from one to forty hours a week.

Procedure: A tachistotachometer with a voice activated withdrawal switch was used. Subjects were given a reading test to determine speed and then asked to respond to 55 braille characters being individually displayed on the tachistotachometer as rapidly as possible. Interstimulus intervals latency and errors were recorded. Ten trials per subject were given and the order of presentation of stimuli was varied.

Results and Conclusions: There was little correlation between the rank orders of difficulty determined by Nolan and Kederis (1969) and this study.

Fifty-two percent of all errors was the misidentification of identical stimulus configurations that could occur in different cell locations. Omission errors accounted for 28% of the errors. Nolan and Kederis, 1969 found that this accounted for 82% of the errors. In agreement with the earlier study, more dots were omitted from the bottom row than from the top row. In opposition to the earlier study more dots were missed on the left side than on the right side.

Gill, J. M. (1978). A study of braille contractions. (Progress Report). Warwick University: Coventry, England.

Purpose: To undertake a study of braille contractions in order to find ways of making braille easier to learn and to read and write.

Procedure: One portion of the study was the compilation and analysis of a questionnaire sent to braille users in the United Kingdom identifying the areas in which it would be most useful to undertake detailed studies. The questionnaire was also designed to give some idea of the popular opinion as to the undertaking of braille code modifications.

The second portion of the study was the compilation and analysis of a collection of words from multiple sources. The analysis was related to the frequency of use of Grade II Braille symbols and signs.

Results and Conclusions: The work was to study the specific problems of braille users and learners and the effects of different types of contractions on reading speed. The final product of this study was to be a report on the braille contraction system and recommendations for changes, if needed, in the system.

Of the surveys that were completed and returned, there seemed to be no desire for change unless it could clearly be demonstrated that there were some significant advantages to be gained.

Mangold, S. S. (1978). The effects of a developmental teaching approach on tactile perception and braille letter recognition based on a model of precision teaching. Dissertation Abstracts International, 38, 4734A.

Purpose: To determine the extent to which a developmental program of tactile perception and braille letter recognition training would affect errors in braille reading.

Subjects: 64 students were tested. Fifteen matched pairs were selected, using five criteria, one of which was pretest scores. The subjects ranged in age from 5 to 15 years and and included beginning braille readers as well as remedial readers. Students from 17 public schools and residential schools were selected and randomly assigned to experimental and control groups.

Procedure: A pretest, treatment, and post test design was used. The treatment portion of the study consisted of a developmental program of tactile perception and braille letter recognition. Enough time was provided so that each student could complete the entire program. The students took between 6 and 16 weeks to complete the program with a mean time for completion of 13 weeks.

Results and Conclusions: Data analysis revealed that, as hypothesized, the experimental subjects demonstrated significantly fewer errors in tactile perception, braille letter recognition, undesirable back tracking behaviors, and undesirable scrubbing behaviors.

Precision teaching assessment techniques used throughout the study resulted in the establishment of criteria for twenty-nine subskills of tactile perception and braille letter recognition.

Newman, S. E., & Hall, A. D. (1979). Braille learning: Exploratory study of input and output modality effects. Unpublished manuscript, North Carolina State University.

Purpose: To determine whether subjects for whom the test-modality was the same as the study-modality on learning the names of the braille symbols would perform better than those subjects whose study and test modalities differed when learning the names of the braille symbols.

Subjects: 64 sighted undergraduates at North Carolina State University. All subjects were right-handed and none had previous experiences with braille. There were an equal number of males and females in each group.

Procedure: Paired-associate learning experiments in which the subjects were self-paced in both study and test trials were conducted. Half of the test-study trials the material was presented visually and half were presented tactually.

When the items were presented visually the subject could not touch them and when they were presented tactually the material was screened so the subject could not see it. The subjects were allowed to touch the material with the flat portion of the index finger only.

Results and Conclusions: Analysis of the results during training indicate that when subjects studied the items visually, they took less time both on study and test trials. These subjects also made more correct responses than when the items were studied tactually. Having the items presented visually on test trials also resulted in quicker and more accurate responding on the test trials though study time was not affected. Accuracy improved with training and study time decreased as did test times. The decline was more marked in the tactual conditions. Subjects in the tactual conditions were still taking more time than those who were either studying or testing in visual conditions. On the fourth trial, however, when test time was equated across treatments neither the effects of study or test modality affected performance. The results of performance during training suggest that visual presentation in either study or test trials is more efficient than tactual presentation.

Caton, H. R., & Pester, E. (1979). Development of a beginning braille reading series. (Final Report) Louisville, KY: American Printing House for the Blind.

Purpose: The development of a beginning braille reading series whose primary objective was to minimize problems encountered by the beginning reader.

Procedure: The following steps were followed in order to develop a beginning braille reading series:

1. detailed coordinated specifications for students' texts, workbook materials, and teachers' editions, using all relevant information from research on braille reading as well as print reading were written

2. common word lists to identify words to be used as vocabulary in the specially designed braille readers were analyzed

3. special braille readers based on these specifications and vocabulary lists were written

4. special braille workbook materials based on these specifications and word lists were developed

5. teachers' manuals meeting those specifications were written

6. all materials as developed were submitted to review by an expert committee and revised as required.

Results and Conclusions: Patterns: The Primary Braille Reading Program was developed and produced by the American Printing House for the Blind.

Research on the Braille Codes
1980-1986

1980-1986

Research in this period included studies of hand movements in braille reading, hand preferences, search patterns, cognitive processes and braille reading, phonological and tactual coding, and a massive study of contractions in British braille. There were also several studies which used sighted students as subjects.

Evaluation. The massive study of contractions in British braille (Gill and Tobin, 1980; Lorimer, Tobin, Gill, and Donce, 1982) was by far the most impressive during this decade. The information related to the frequency of occurrence of braille contractions is invaluable in considering modifications of the existing codes and development of materials for braille readers. The other studies cited above are well done, but most suffer from the same problems of sample size and representativeness which has been mentioned earlier. The value of studies which used sighted subjects is questionable.

Abstracts of Braille Studies
1980-1986

Newman, S. E., Hall, A. D., Goldston, D. B., DeCamp, B. L., Granberry-Hager, S. P., Lockhart, J. L., Sawyer, W. E., White, J. E. (1980). Some factors affected the learning of braille. Montreal: Paper presented at meeting of the American Psychology Association.

Purpose: To study the relationship between study modality and item size.

Subjects: 96 right-handed male undergraduates at North Carolina State University, none of whom had had previous experience with Braille.

Procedure: Braille symbols in either regular braille or large braille were presented to subjects, who were to learn the name for the braille symbol of the first 10 letters of the alphabet.

Five study trials were given, followed by a test trial. The subject examined each item for ten seconds haptically during the test. The subject's right hand was covered so that visual examination of the symbols was precluded. Each symbol was explored by rubbing the flat portion of the right index finger over the symbol. Two sets of orders were used, each for half of subjects in each treatment.

Results and Conclusions: Visual subjects did better than haptic subjects on the regular Braille items, but not on large Braille items. This finding supported the author's suggestion that visual examination of the items facilitated encoding for each item.

Davidson, P. W., & Wiles-Kellerman, M. (1980). Relationship between hand movements, reading competence, and passage difficulty in braille reading. Neuropsychologia, 18, 629-635.

Purpose: To quantitate specific features of hand and finger movements in braille reading and to correlate these movements with other variables known to influence reading such as reading ability of the subjects and reading difficulty of the stimulus material.

Subjects: 18 adolescents with vision no better than light perception, ranging in age from 13 to 21 were used for this study. The mean age was 16.38 years; mean IQ 92.2. The subjects were grouped into four reading ability groups based on the WRAT. The mean grades for the groups were 4.9 (n=5), 6.8 (n=5), 9.9 (n=4) and 14.1 (n=4). Subjects' IQs were in normal range and were positively correlated with reading grade levels.

Procedure: Four reading passages representing grades 2, 4, 8, and 12 were given to the subjects to be read aloud. As they read, two cameras at different angles photographed the material and the finger/hand movements. At the end of each passage, the subjects were given tests to measure the free-recall and recognition.

Three separate scorings of the hand and finger movements were performed. (a) four global styles (similar to Kusajima, 1974), (b) the incidence of and duration of regresses, and (c) fixations. Oral reading errors were scored as an index of reading accuracy.

Results and Conclusions: Several aspects of blind subjects had movements in this study seem theoretically important:

1. A considerable number of scanning features were common to all our readers, regardless of the ability or experience level.

2. The consistent use of regressive movements by all subjects and the similarities of single regress duration across all reading groups suggest another function of haptic scanning--one consequence of sequential information pickup is the burden placed on the short term memory. Therefore, the regressive movements may help to synthesize the haptic information and help the short term memory.

3. Less frequent multiple regressions occur in proficient readers suggesting that this scanning method is less efficient than the single regression. This finding is correlated in the increased oral reading errors and use of long duration multiple regresses.

4. This study indicates strong correlations between braille reading proficiency, retention and scanning style.

Gill, J. M., & Tobin, M. J. (1980). A study of braille contractions 1977-1980 (Final Report in Four Main Volumes) London: Department of Health and Social Security.

Purpose:

1. To explore the possibility of producing an alternative Grade 2 Braille Code that would be shorter and simpler to learn but could be read as fast as the existing Grade Two Code and would not require more space and

2. Investigate ways of improving teaching methods and materials.

Procedure:

1. Literature surveys

2. Questionnaires for opinions, suggestions and attitudes

3. Compilation and study of data bank of braille literature for braille signs, contractions and abbreviations with cross validation to other existing word and frequency counts

4. Experimental comparisons of possible alternative modified codes to determine their effects on reading speed

5. Trials of different methods of improving reading efficiency among readers already competent in braille

Results and Conclusions:

1. Computer based frequency counts demonstrated (a) that 50% of the signs of Braille Grade Two occur so infrequently that their retention cannot be justified solely on the grounds of their space saving, (b) that 50 to 60 of the present signs could be deleted with an increase in space of less than 1%, (c) some 20 words and groups of letters, if represented by new contracted forms, would save at least twice the amount of space now saved by the weakest 60 contractions, and (d) the space saving effects of other possible new contractions become progressively smaller, with some 60 being needed to reduce grade 2 space by 5%.

2. The analysis and experiments points to a set of simple "pruned-down" versions of existing grade 2 braille from which an acceptable and readily learnable and usable code could now be selected if no increase in bulk were to be the criteria of choice.

3. The findings of this project suggest that, within the limits set by the investigators, a code containing about 120 contractions (including a few new ones) would be an optimal size, allowing scope for some reduction of rules while well maintaining the space-saving efficiency and ease of reading of the present Grade Two Code.

4. The researchers have verified earlier studies that show that braille presents special cognitive and perceptual difficulties owing to its characteristics of multiple meanings and its physical structure.

5. All teachers should assume the responsibility of helping to teach and motivate students to higher braille reading levels as braille is shown to be a skill that increases with practice.

Bradshaw, J. L., Nettleton, N. C., & Spehr, K. (1982). Braille reading and left and right hemispace. Neuropsychologia, 20, 493-500.

Purpose: To determine whether there is left- or right-hand preferences in locating phonologically and semantically defined targets in Braille lists.

Subjects: 12 blind persons aged 28-57 years.

Procedures: The subjects were timed in locating phonologically and semantically defined targets in braille lists. The "reading" hand was placed either out from or across the body, i.e., in ipsilateral or contralateral hemispace.

Results and Conclusions: Contrary to previous reports, there was no evidence of either a general left-hand preference or an overall left-hand superiority. Neither the magnitude nor the direction of hand superiorities changed when hands were tested in contralateral hemispace. In this complex task, hemisphere hand connections appear more important than hemisphere-hemispace relationships. It appeared that left-hand (or left-hemispace) dominance in tactual tasks of a verbal nature may occur only with novel, unfamiliar materials, or with materials that are perceptually more difficult to discern.

Krueger, L. E. (1982). A word superiority effect with print and braille characters. Perception and Psychophysics, 31, 345-352.

Purpose: To determine if letter search through braille non-words would be slower as is true of letter search through print non-words.

Subjects: In experiment I, seven blind adults familiar with braille and ranging in age from 19 to 30 years of age were used. In experiment II, 24 Ohio State University undergraduates participated as a course requirement. All of these subjects had at least 10/30 vision (corrected) as measured by a Snellen Chart. In experiment III, 11 blind adults familiar with braille and ranging in age from 20-53 years. Three of the subjects had served as subjects in experiment I.

Procedure: In experiment I, the subjects were presented with 36 displays containing five rows of five six-letter items in slightly oversized Braille. In experiment II, subjects were presented 48 displays of five rows of five six-letter words or non-words. Sometimes the subjects were asked to target for one, two, or three letters. Experiment three replicated experiment I with the exception that no letter sequence that would form a grade 2 contraction was used.

Subjects were asked to examine either braille or print displays for target letter(s). The displays were sometimes words and other times non-words conforming to the same target letter positioning as the words.

Results and Conclusions: Experiment I found that with Grade 1 braille, as with print, letter search is about 10% faster through common words than through non-words. Thus, braille like print, is processed in neither an entirely holistic manner, with the word gestalt concealing its letter components, nor in an entirely analytical manner, with each letter dealt with separately and independently.

Experiment II and experiment III both found a word advantage in letter search through words and non-words containing no spelling patterns that form a contraction in grade 2 braille. Experiment II also confirmed previous work showing that the time savings for words does not vary when the memory set size (number of predesignated target letters) is varied. This indicates that the word advantage is with encoding rather than comparison.

Lorimer, J., Tobin, M., Gill, J., & Douce, J. (1982). A study of braille contractions, London, England: Royal National Institute for the Blind.

Purpose: To generate the kind of information necessary to formulate decisions about code modifications. Such modifications would be designed to improve the existing grade 2 braille code to improve its learning and reading. The study also considered how improvement in teaching methods and materials might be accomplished.

Procedures: Methodology of this study included:

1. literature surveys to ascertain the current state of knowledge

2. questionnaires to discover the opinions, suggestions, and attitudes of Braille users and producers

3. compiling a data bank of a large sample of braille literature for analysis and frequency counts to be made of braille signs, contractions, and abbreviations for cross-validation purposes. Other word and frequency counts were examined as well

4. experimental comparisons of possible alternative, modified codes to determine their effect on reading speed

5. trials of different methods of improving reading efficiency among readers already competent in braille

Results and Conclusions:

1. (a) 50% of the signs in Grade 2 braille occur so infrequently that their retention is justified only on space saving.

   (b) 50 to 60 of the present signs could be deleted with an increase in space of less than 1%.

   (c) some 20 words and groups of letters, if represented by new contracted forms, would save at least twice as much space as the 60 weakest contractions

   (d) space saving effects of other possible new contractions become progressively smaller

2. The nine experiments show that reduced codes can be devised that will not affect reading speeds and will not increase bulk of materials.

3. A large reduction of the number of governing rules is not possible without an unacceptably large increase of embossed space or unless the present system of contractions is radically altered. The findings of this project suggest that a code containing about 120 contractions would be optimal size allowing for some reduction of the rules, maintaining the space saving efficiency and ease of reading of the present Grade 2 code.

4. Like earlier researchers these findings show that braille presents special cognitive and perceptual difficulties due to its multiple meanings and physical structure.

5. Teachers at all levels need to continue the "reading" instruction of all students.

Wilkinson, J. M. (1982). Cognitive processes and braille reading strategies in the blind. Dissertation Abstracts International, 43, 538-B. (University Microfilms No. DA8212477).

Purpose: To investigate cognitive processes and braille reading strategies that are related to hand preferences and reading skill in blind children and adults.

Subjects: 63 right-handed, totally blind readers, 24 males and 29 females.

Procedure: Hand preference and reading skills were assessed and observed in four experimental tasks designed to expose coding strategies in the following:

1. letter identification
2. word recall with tactually or phonologically confusing words
3. same-different letter matching with tactually similar or dissimilar letter pairs, and
4. paragraph reading with and without a concurrent verbal/phonological memory load.

Results and Conclusions: The results were generally consistent with predictions about reading hand strategies and preferred coding processes. Right-handed readers process phonological codes faster whereas left-handed readers process tactual codes faster. Recognition and discrimination of letters as well as reading of paragraphs suggested an underlying advantage for left hand processing that could either exaggerate or greatly reduce the preference for left or right hand reading, respectively. This finding provides simultaneous support for Hermelin and O'Connor's tactual-spatial feature hypotheses and for the idea that strategies can be developed that modify the mode of processing.

Bertelson, P., & Mousty, P. H. (1982). Modes operatories dans la lecture de l'ecriture braille (Operational modes in reading braille), Travail Humain, 45, 13-23.

Purpose: To study hand movements in braille reading.

Subjects: 24 blind persons.

Procedures: The hands of 24 blind persons were videotaped while they read normal prose, with either or both hands.

Results and Conclusions: It was found that patterns of two handed exploration varied widely among subjects and that subjects resorted to two principles of hand collaboration. Conjoint exploration where both hands examined the same passage for a short interval and disjoint exploration where the hands dealt successively or simultaneously with different passages. Both principles allowed for faster reading than one handed reading but the locus of the gain seemed to be different in the operating mode. The fastest readers resorted to disjoint exploration more often than the slower ones.

Pring, L. (1982). Phonological and tactual coding of braille by blind children. British Journal of Psychology, 73, 351-359.

Purpose: To examine whether or not phonological effects will arise in word naming by blind children or whether the tactual code constructed in the initial stages of reading can itself be sufficient to gain lexical access directly. To explore the possibility of a phonological effect in reading aloud, namely a word regularity effect.

Subjects: Eight boys and four girls from a residential school (Dorton House) for the blind. All congenitally blind with no better than light perception. All had normal to above average intelligence and no other handicaps. The mean age was 12 years 3 months.

Procedure: A congruent list and an incongruent list of words were used. Each list had eleven pairs of words. In the congruent list, the words had phonology and orthography that provided no inconsistency. In the incongruent list the preceding word was similar in orthography but inconsistent in phonology with respect to the target word.

All words were brailled on 4 x 6 inch index cards with the use of a Perkins Brailler.

The children were instructed to read the words aloud as rapidly as possible without errors when they heard an auditory signal to start. Their voice stopped a digital timer that was begun with the start signal. Half of the children were given one list and half of the children were given the other list to begin. After a thirty-minute period in which the children were involved in a non-related task they were given the list they had not read.

Results and Conclusions: Errors were few and did not indicate a speed/error trade off. The children took significantly longer to name the target word when it was preceded by a tactually similar but phonologically dissimilar word than when it was preceded by a word that neither tactually not phonologically very similar.

Experiment two (using the same children and apparatus but a different two sets of words, 13 regular and 13 irregular in terms of their grapheme to phoneme correspondence). Results indicate the advantage of regular words in speed of naming (reading) suggests that they can be read either with or without reference to the lexicon as opposed to irregular words that subjects may be able to pronounce only on the basis of direct lexical access.

Czerwinski, M. H. (1983). An examination of blind children's symbol knowledge in the areas of reading and mathematics. Dissertation Abstracts International, 43, 3285-A.

Purpose: To examine the Braille symbol knowledge of blind children in the areas of reading and mathematics.

Subjects: 40 blind students from local school programs who used Braille in reading and mathematics in grade levels one through nine.

Procedure: A reading test and a mathematics test were developed by the author and administered to the subjects. Data analyses consisted of correlations to evaluate the relationship of grade level to knowledge of grade 2 braille contractions. In addition, percentages of braille contractions known in both reading and mathematics were calculated.

Results and Conclusions: Results of these analyses indicated that knowledge of braille contractions was significantly related to reading grade level for grades one through six, but not for grades seven through nine. In addition, the percentage of grade 2 braille contractions in mathematics and reading for each grade level were given. The percentages were based on correct responses on the two braille tests developed by the author by at least 75% of the subjects.

In addition, the percentage of braille signs known by blind students at each of the grade levels was determined along with the braille signs themselves for both reading and mathematics during the study. The percentages were based upon a correct response on the Braille tests by 75% or more of the subjects at each grade level.

Krueger, L. E., & Ward, M. E. (1983). Letter search by braille readers: Implications for instruction. Journal of Visual Impairment and Blindness, 77, 166-169.

Purpose: To review the evidence on the speed and accuracy of letter search through braille words and non-words.

Procedures: The article repeats the findings of Krueger's 1982 series of three experiments and draws conclusions. The authors present techniques for using letter search in the teaching of Braille.

Results and Conclusions:

1. Both braille and print readers showed superior letter search abilities with words as opposed to non-words.

2. The percentage of errors were lower for words than for non-words.

3. Braille readers were two to three times slower than print readers yet the percentage of time saved was virtually identical.

4. Braille readers were therefore behaving as print readers and like print readers can use the context of words to speed their search for letters.

5. Educationally the child should be given a great deal more practice with specific letter search to

    a. become more comfortable with their shapes

    b. to increase the beginning and intermediate braille readers' number of character impressions per unit of time

    c. to give the student formality with common spelling patterns.

Newman, S., et al. (1984). Braille learning: Effects of symbol size. Baltimore, MD: Paper presented at the Eastern Psychological Association, (ERIC Document Reproduction Service No. ED 246 602).

Purpose: To determine the effect of the size of the braille cell on rate of learning the names for braille symbols of letters of the alphabet (A-J and K-T).

Subjects: 80 sighted subjects.

Procedure: Subjects were given a study session and a test session. Materials were transcribed in standard and enlarged braille. Study size (standard or large braille), test size (standard or large braille), and item set (A-J or K-t) were manipulated in a study-test procedure (each of five study trials followed by a test trial).

Results and Conclusions: Performance was facilitated by large braille symbols during test and study trials, particularly if symbol discrimination is difficult. Faster learning of the A-J than the K-T set was evidenced.

Newman, S. E., Kindsvater, M. S., & Hall, A. D. (1985). Braille learning: effects of symbol size. Bulletin of the Psychonomic Society, 23 (3), 189-190.

Purpose: To show that the rate of learning the names for each of a set of items is ordinarily a direct function of the degree to which the items are discriminable from one another.

Subjects: 80 right-handed male subjects enrolled in an introductory course in psychology at North Carolina State University.

Procedure: The subjects used the index finger of the right hand to examine each item haptically. Visual examination of items was not prevented. Each of the five study trials was followed by a test trial. On study trials, each symbol was haptically examined for ten seconds along with the name of the symbol. On trials, each symbol was examined for ten seconds and the letter name then was called out by the subject.

Results and Conclusions: Learning the names of braille symbols is facilitated if large braille symbols are used during test trials, especially if standard braille symbols are used during study trials. Also, reading the symbols is facilitated if large braille symbols are used during study trials and standard size symbols are used during test trials. Therefore, it might be desirable to use large braille for all items both on study trials and on test trials, at least during early training.

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Newman, S. E., & Hall, A. D. (1986). Amount learned from two alphabets used with the blind. New York: Paper presented at the Annual Meeting of the Eastern Psychological Association.

Purpose: To compare the amount learned from the Braille alphabet and from the Fishburne alphabet within a fixed period of time.

Subjects: 72 male students enrolled in the introductory psychology course at North Carolina University.

Procedure: Each subject was given a study sheet with either the braille symbols and their letter names, or the Fishburne symbols and their letter names in various arrangements. Subjects were given eight minutes to study the symbol-letter pairs and then were tested.

Each symbol was presented for ten seconds on the test, and the subjects were to respond with the letter name. All subjects studied the test items visually and were tested visually.

Results and Conclusions: The amount learned from the Fishburne alphabet was greater than from the braille alphabet. The Fishburne system may prove helpful to the visually impaired in two ways: (a) as an alternative to braille for labeling items for personal use; and (b) as a preliminary task for those who find braille too difficult to learn.

Newman, S. E., Hall, A. D., Amein, J. C., & White, J. E. (1986). Rate of learning braille with the left and right hand. Washington, DC: Paper presented at the annual meeting of the American Psychological Association.

Purpose: Experiment 1 was to show the extent to which the faster learning of braille by the left hand is a function of haptic discriminability when learning the names for the symbols. Experiment II was done to determine whether the rate of learning is faster when the hand used on test trials is the same as that used during study trials.

Subjects: In experiment I, sixty-four sighted undergraduates in the introductory psychology course at North Carolina State University. All were right-handed with no previous experience with braille. Both male and female subjects were used.

In experiment II, 48 sighted, male undergraduates in the introductory psychology course at North Carolina State University. All were right-handed with no previous experience with braille.

Procedure: The subjects were to learn the names for either the first 10 symbols (A-J) or the second ten symbols (K-T). Subjects were given five study trials followed by a test trial. On the study trial, the symbol was presented for ten seconds with the letter name. On the test trial, each symbol was presented for ten seconds after which the subject was to call out the letter name. Half of the subjects examined the items with the index finger of the left hand, and the rest of the subjects used the right hand index finger. Subjects were not allowed to view any of the symbols they were learning.

Experiment II was similar to experiment I except that test hand and study hand differed, three trials were given instead of five, and all subjects were made.

Results and Conclusions:

1. Subjects using the right hand performed as well as subjects using the left hand, in both experiments. However, using the same hand for study trials and test trials increased the rate of learning while using different hands slowed learning.

2. Symbols (A-J) were learned faster than symbols (K-T).

3. Females performed better than males.

4. For both experiments, the order of difficulty of items was similar.

5. The pattern of errors was similar for both experiments.

There appears to be no simple answer to the question, "Which hand is the 'eye' of the blind?" (Harris, 1980), and "Is there a 'best hand' for braille?" (Miller, 1904).

Newman, S. E., Craig, R. A., & Hall, A. D. (1986). Judgement of dot numerosity to braille symbols by blind and sighted subjects. Orlando, FL: Paper presented at the annual meeting of the Southeastern Psychological Association.

Purpose: By using a group of adult blind subjects, the authors tried to determine if the number of dots in a braille symbol would be overestimated or underestimated. Also, they were trying to determine if there was a significant positive correlation between the number of errors for each symbol and the number of dots it contained.

Subjects: 18 legally blind people participated, (12 male and 6 female). They were a heterogeneous group, differing in nature and severity of visual impairment. All were in the process of training at the North Carolina Rehabilitation Center for the Blind.

Procedure: The subjects were asked to tell the number of dots contained in each of twenty-one symbols. They were given ten seconds to examine each symbol, using their index fingers. They were given three trials, and on the last trial the circumference of the right index finger was measured (at the base of the fingernail).

Results and Conclusions: The results of this experiment showed that judging the number of dots in a braille symbol may not be an easy task, especially for those with no previous knowledge of braille. For both sighted and blind, there appeared little improvement over trials. Errors of underestimation tended to exceed errors of overestimation.

Since both the sighted and visually impaired had the same difficulties in the study, then the results from research in perceptual learning and memory tasks for the sighted may be helpful in understanding the processes being used when the same task is done by the visually impaired.

Khan, S. B., & Kirkland, K. H. (1986). A study of the influence of capitalization/no capitalization in braille on the reading comprehension and reading speed of braille-using elementary and secondary school students. Brandford, Ontario, Canada: The W. Ross MacDonald School for the Blind.

Purpose: To investigate the effects of capitalization and no capitalization in braille on the reading comprehension and reading speed of a group of blind elementary and secondary students.

Subjects: 52 students from the W. Ross MacDonald School for the Blind located at Brandford, Ontario, Canada. There were sixteen elementary students (eight males and eight females), and thirty-six secondary students (fifteen males and twenty-one females).

Procedure: Passages from geography textbooks on levels for both the elementary group and the secondary group were chosen. Each passage at each level included one copy with capitals and one copy with no capitals. Students were given both types of copies (one with capitals and one without) and were timed on the length of time required to read each copy. Questions of comprehension were asked after the reading.

Results and Conclusions: The results showed that both at the elementary and secondary levels an equal amount of time was required to read passages with and without capital letters. The results of this study also showed that the time required to read with comprehension was not influenced with or without capital letters. However, this study was done on a small sample in only one institution.

A majority of the students in this study preferred reading with capital letters. However, there was no difference either in time taken to read meaningfully or to comprehend the materials read.

Summary and Conclusions

This section of the report will summarize research in each of the 10-year periods from 1900-1986. Areas in which research is needed (gaps) will be identified and an attempt will be made to prioritize these needs.

1900-1919

Studies during this period focused on:

1. embossed print vs. embossed dot systems

2. grade 1 1/2 braille vs. grade 2 braille

A 20-year period was included in this section because of the limited research during this era and the fact that the majority of the studies were done by the Uniform Type Committee. They compared a number of embossed dot systems in an attempt to aid in the selection of the better system.

1930-1939

Studies during this period were related to:

1. writing of braille

2. the use of contractions in beginning reading

3. legibility of braille characters

4. tactual perception of braille characters

5. braille symbols for chemical notations

6. comparison of reading speeds and comprehension

Only seven studies are reported for this 10-year period, indicating that research activity in braille was very limited at this time. The areas of tactual perception and finger sensitivity received slightly more attention than other areas. The problem here, as in other time periods, is that very few studies were conducted in each area. Replication is needed in order to accept and generalize the findings.

1940-1949

During this period studies were related to:

1. speed of reading
2. hand movements
3. tactual sensitivity
4. hand dominance
5. frequency of occurrence of grade 2 braille contractions in children's books

Results of these studies were among the first to have a direct bearing on the development of educational procedures and materials for blind children. However, the number of studies was, again, very limited. Only seven studies which directly related to the braille code were found. The studies by Eatman (1946) are particularly important because they deal with specific characteristics related to the physical act of reading braille. Very few studies have dealt with this important aspect of braille. This represents a significant gap in research on the braille code both prior to and subsequent to the Eatman study. The Hooper (1946) study was also significant in that it was one of the first to look at the rate of occurrence of contractions in children's reading materials. A few studies subsequent to this (Rex, 1970 and Lorimer, Tobin, Gill, and Donce, 1982) have investigated this topic, but information for current materials in the United States is not available.

1950-1959

Studies during this period focused on:

1. configuration of braille symbols
2. size of dots in the cell
3. spacing of dots in the cell

Studies during this period focused almost exclusively on the physical characteristics of the braille cell. The Myers and Ethington (1958) and Myers, Zickel, Ashcroft, Clark, and Calvin (1958) have set the physical standards for the braille cells which

are used today. These studies were extensive and the results are probably as valid today as they were at the time the studies were conducted. An interesting study from the Dueren School for the Blind in Dueren, Germany looked at mental as well as physical processes in braille reading.

1960-1969

Studies during this period were related to:

1. errors in oral reading of braille
2. analysis of braille errors for elementary children
3. hand use and touch movements
4. braille writing
5. mechanical translation of braille
6. legibility of braille characters
7. braille use vs. talking book use
8. braille recognition thresholds
9. frequency count of braille symbols
10. automated training and braille reading
11. programmed instruction in braille
12. teaching braille to adults
13. diagnostic test of braille perceptual skills
14. full length vs. telegraphic braille
15. exploration of an expanded braille code
16. reading speed and comprehension
17. braille teaching practices
18. a wide variety of perceptual factors in braille word recognition
19. braille word recognition by readers of low intelligence

This was, by far, the decade in which the most research and, to some extent, the most significant research on the braille took place. The most significant works during this period were the Ashcroft (1960) study of braille errors of elementary children, Lowenfeld, Abel, and Hatlen (1969) study of the practices of teachers of children who read braille, and the Nolan and Kederis (1969) studies of the perceptual factors of braille word recognition. It would appear that the perceptual factors studies are extensive and complete and replication would not be necessary. However, the characteristics of the populations of children have changed significantly since the Ashcroft and Lowenfeld, Abel and Hatlen studies were conducted. Since those studies provided information which is the core of knowledge needed in order to evaluate the effectiveness of the codes, it is imperative that they be replicated with the populations as they exist today.

1970-1979

In this decade, studies focused on:

1. analysis of basal readers (print) to determine what problems resulted from translation into braille
2. comparison of approaches for teaching braille reading
3. effects of order of presentation
4. comparison of braille and rapid speech
5. character recognition training
6. code revisions
7. rapid reading techniques
8. functional difference of fingers while reading braille
9. increased reading rate and comprehension
10. comparison of braille, normal reading, and speeded reading
11. pacing and rapid reading related to instruction and comprehension by school age children
12. tactual hierarchy

13. visual braille and print reading

14. identification of characters

15. British contraction study--initial reports

16. developmental teaching materials

17. input and output modality effects

The majority of the studies related to the ordering of the code and the effects of drill on recognition and comprehension were well done. These are extremely important studies. The problem which occurs is that only one or two studies related to the same topic are conducted. For example, it would be useful to have more information related to the tactual hierarchy. The initial reports on the British braille study appeared during this period. The full report is reviewed in the next section of this report.

Several studies related to teaching children to read braille are included in this section because this aspect of braille cannot be separated from the physical aspects of the system. Much more work in this area must be done in all English speaking countries if we are to know how effective the code(s) we adopt are.

1980-1986

Studies during this period covered the following topics:

1. hand movements in braille reading

2. hand preference in braille reading

3. search patterns

4. cognitive processes and braille reading

5. phonological and tactual coding

6. study of contractions in British braille

7. studies related to modality and symbol size

The complete report of the British contraction study appeared during this decade. It furnished valuable information related to the frequency of occurrence of braille contractions which will be useful in considering changes in existing codes as well as the development of braille materials. Without doubt, this braille study was the most significant study during this decade. This is an extremely well done and complete study on the contractions in British braille. Such a study must be conducted on American braille if decisions related to a common code can be made.

Other studies during this period which were related to hand movements, etc. are of value to teachers. The studies in which sighted subjects were used are of questionable value.

Summary Statement

Discussions of research conducted in each of the 10-year periods appear in the Summary and Conclusions section above. Brief discussions of strengths and weaknesses as well as the gaps in each period are included. Basically, it appears that almost every aspect of the braille codes has been studied at some time during the period from 1900-1986. The major problems are that many of the studies are very old and need to be replicated and that very few studies were done on most topics.

Based on the information gained from this review of research on braille, it appears that a coordinated program of braille research needs to be developed among the various English speaking countries. This program should include:

1. A complete study of contractions in American braille, similar to the British study.

2. A study of the kinds of errors made by school-age children and adults who read braille.

3. A study of the relative difficulty of different categories of the braille code.

4. A study of problems in speed and comprehension encountered by children who read braille.

5. A study of the effects of various kinds of instructional procedures and materials on the efficiency with which children and adults learn to use the braille code is needed. This is an area which has been greatly neglected. It is possible that this aspect of learning

to use braille is as important (or even more important) than the physical characteristics of the braille symbols. In short, it seems that much more information relative to the efficiency with which children and adults learn to read braille is needed before decisions about developing a new code are made.

It is critically important that a well-planned program of research on the braille codes be undertaken if changes in these codes are to be considered. This must be a coordinated program of research in which representatives from all English speaking countries participate. This is the only approach which would allow for a systematic comparison of the different codes in use today so that valid decisions related to changes in those codes can be made.

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